# REPORT RESUMES

ED 003 788    64

CUE (CULTURE, UNDERSTANDING, ENRICHMENT)--SCIENCE.
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NEW YORK STATE EDUCATION DEPARTMENT, ALBANY
REPORT NUMBER NDEA-VIIB-324-4    PUB DATE    64
EDRS PRICE MF-$0.36 HC-$8.28   207P.

DESCRIPTORS- *TEACHING GUIDES, SCIENCE CURRICULUM, *SCIENCE INSTRUCTION, SCIENCE PROGRAMS, CULTURAL ENRICHMENT, CURRICULUM ENRICHMENT, *ENRICHMENT PROGRAMS, CULTURAL AWARENESS, INSTRUCTIONAL AIDS, INSTRUCTIONAL IMPROVEMENT, *AUDIOVISUAL AIDS, SECONDARY EDUCATION, GRADE 9, *GUIDES, EDUCATIONAL PROGRAMS, ALBANY, NEW YORK, PROJECT CUE

THIS PUBLICATION IS A TEACHING GUIDE TO PROVIDE GUIDANCE FOR INTEGRATING CAREFULLY SELECTED AUDIOVISUAL ITEMS INTO EXISTING NINTH-GRADE CURRICULUMS IN SCIENCE. IT IS ONE OF FIVE GUIDES PREPARED FOR USE IN PROJECT CUE, AN EXPERIMENTAL PROGRAM DESIGNED TO INCREASE CULTURAL UNDERSTANDING AND ENRICHMENT IN THE EDUCATIONAL PROGRAMS OF HIGH SCHOOLS. THE AUDIOVISUAL MEDIA INTRODUCED BY THIS GUIDE ARE RELATED TO (1) THE HUMAN BODY AND ITS SENSES, (2) LIGHT AND COLOR, (3) SOUND, (4) PLANT AND ANIMAL LIFE, (5) MEDICINE, (6) TIME AND SPACE, (7) ENERGY AND MACHINES, (8) COMMUNICATION, AND (9) PHOTOGRAPHY. THE ACTUAL TYPES OF MEDIA TO BE USED INCLUDE FILMS, FILMSTRIPS, SLIDES, AND FLAT PICTURES. EACH AUDIOVISUAL AID INTRODUCED IN THE GUIDE IS INDIVIDUALLY TITLED (FOR EXAMPLE--"SOUND WAVES AND THEIR SOURCES," A FILM), AND PROCEDURES ARE DESCRIBED FOR THE USE OF EACH AID. THE AIDS ARE TO BE TREATED AS LESSON SUPPLEMENTS AND USED ONLY FOR INSTRUCTIONAL ENRICHMENT. (REFER TO ED 003 785 THROUGH ED 003 792 FOR THE COMPLETE SERIES OF PROJECT CUE TEACHING MATERIALS.) (JH)

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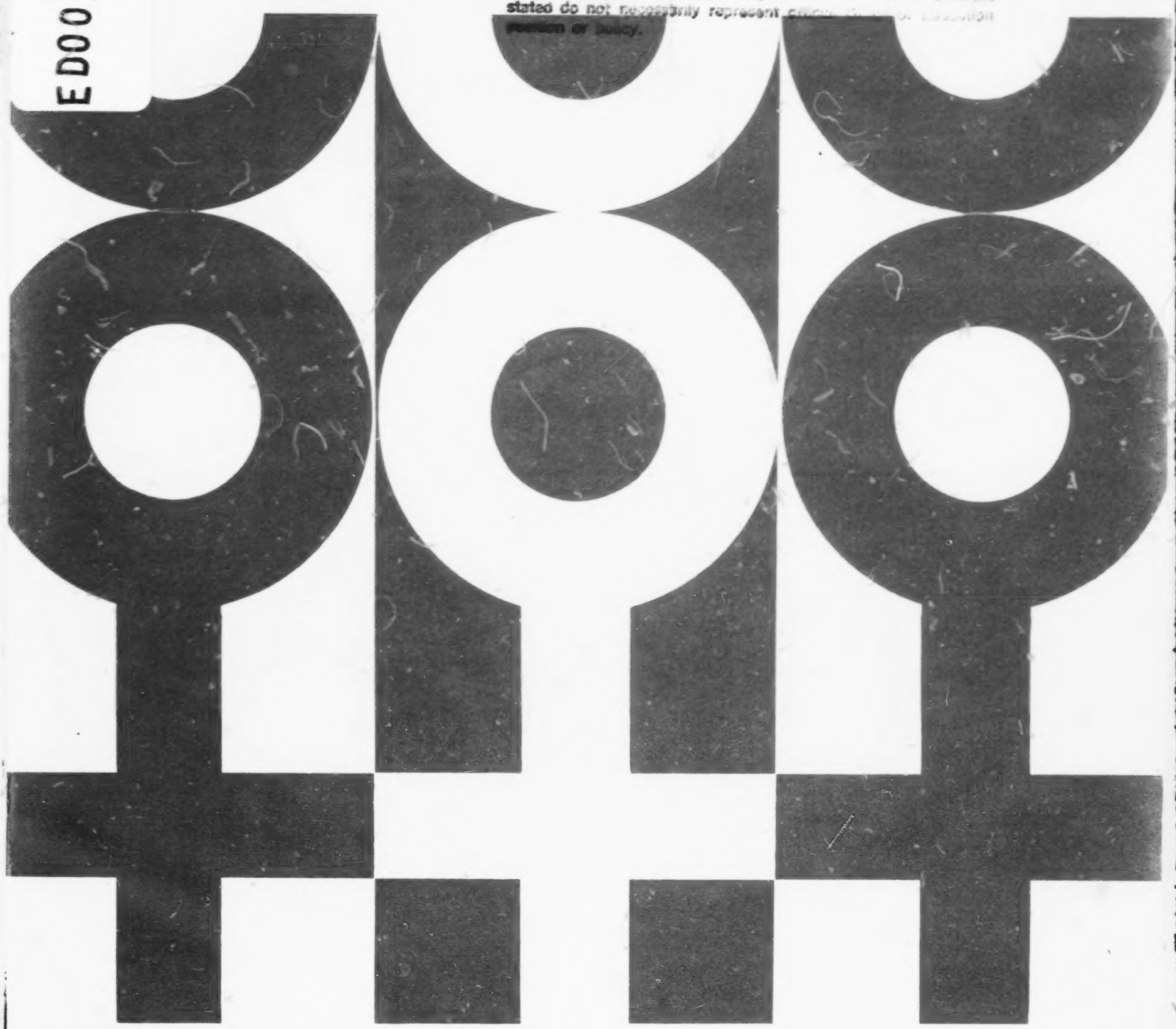

# CUE

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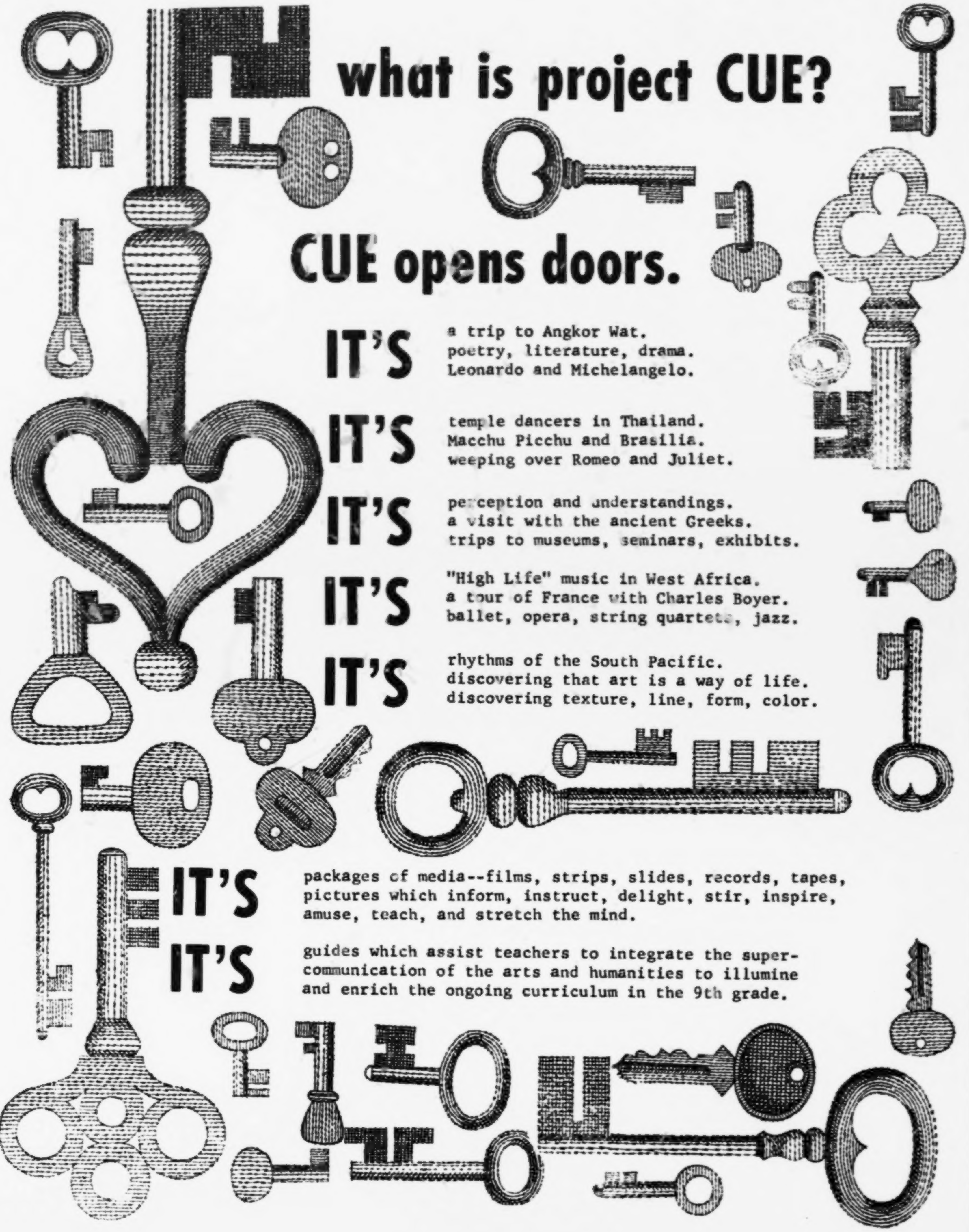


# what is project CUE?

## CUE opens doors.

**IT'S**
a trip to Angkor Wat.
poetry, literature, drama.
Leonardo and Michelangelo.

**IT'S**
temple dancers in Thailand.
Macchu Picchu and Brasilia.
weeping over Romeo and Juliet.

**IT'S**
perception and understandings.
a visit with the ancient Greeks.
trips to museums, seminars, exhibits.

**IT'S**
"High Life" music in West Africa.
a tour of France with Charles Boyer.
ballet, opera, string quartets, jazz.

**IT'S**
rhythms of the South Pacific.
discovering that art is a way of life.
discovering texture, line, form, color.

**IT'S**
packages of media--films, strips, slides, records, tapes, pictures which inform, instruct, delight, stir, inspire, amuse, teach, and stretch the mind.

**IT'S**
guides which assist teachers to integrate the super-communication of the arts and humanities to illumine and enrich the ongoing curriculum in the 9th grade.

"TO SEE LIFE; TO SEE THE WORLD; TO EYEWITNESS GREAT EVENTS; TO WATCH THE FACES OF THE POOR AND THE GESTURES OF THE PROUD; TO SEE STRANGE THINGS--MACHINES, ARMIES, MULTITUDES, SHADOWS IN THE JUNGLE AND ON THE MOON; TO SEE MAN'S WORK--HIS PAINTINGS, TOWERS AND DISCOVERIES; TO SEE THINGS THOUSANDS OF MILES AWAY, THINGS HIDDEN BEHIND WALLS AND WITHIN ROOMS, THINGS DANGEROUS TO COME TO; THE WOMEN THAT MEN LOVE AND MANY CHILDREN; TO SEE AND TO TAKE PLEASURE IN SEEING; TO SEE AND BE AMAZED; TO SEE AND BE INSTRUCTED; THUS TO SEE, AND TO BE SHOWN, IS NOW THE WILL AND NEW EXPECTANCY OF HALF MANKIND." *LIFE

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
ALBANY 1964

V360-Ag64-1,000

The research reported herein was supported by a grant from the United States Office of Education, Department of Health, Education and Welfare.

# NOTICE

Although more than a year was spent in locating, testing and evaluating the materials contained in the CUE guides the final writing of lesson plans was completed in just a few weeks under extreme pressure and limited staff this summer in order to be able to put these printed guides into the schools by fall. Despite editing this haste permitted some typographical and other minor errors to slip through. These minor flaws in no way impair the usefulness of the guides which are still considered working papers. All of these errors will be eliminated at the completion of the experiment.

The CUE Staff

# FOREWORD

Two recent trends in education met in an exciting study, known as Project CUE, culture, understanding, enrichment. The first trend was the growing recognition on the part of educators and laymen, for doing a better job of teaching the arts, the humanities, in the public schools. The second trend recognized the potential impact of a well organized "system" of instruction to support the teacher in his day-to-day teaching.

The combination of these two ideas prompted the United States Office of Education to give the New York State Education Department a grant to integrate the arts into the curriculum through the technique of a carefully planned system of instruction, based upon media-materials, curriculum guides, and suggested methodology and techniques for implementing the program. The Division of Educational Communications and the Bureau of Secondary Curriculum were assigned the task of operating the project under the directorship of Dr. Robert Brown and Mrs. Grace N. Lacy.

Although the teaching of the humanities has been taking place in many schools in the country for many years, the study being made by the Education Department represented several different approaches. First, it was decided that the humanities were for all students and not just for a select few, who chose to elect a special humanities course at a particular grade level. Second, the humanities are part of all subject area content and should be recognized and appreciated in that context. Third, a carefully prepared program of media, materials and methodology could enable the teacher and student to teach and learn in a superior way. With these three points in mind, 13 experimental schools were selected to integrate the humanities program into the ninth grade curriculum.

In July, 1963, nine teacher consultants came to Albany to select the materials suitable to their subject areas. They then wrote lesson plans for use of the materials, under the direction of Mrs. Lacy. The lesson plans were edited by the Bureau of Secondary Curriculum and the assigned subject matter specialists, published, and sent to the 13 project schools. Packages of the chosen materials were assembled and sent to the schools by the Division of Educational Communications.

Mrs. Lacy visited all schools to orient the teachers to the program and explain the CUE system. Curriculum and audiovisual coordinators in each school acted as liason persons between the school and the CUE staff. Throughout the year the materials and guides were used and evaluated by the CUE teachers. As a result of one year's use, the materials and guides have been revised and upgraded in the light of the criticisms and suggestions of more than 250 teachers. Dr. Brown conducted testing in all schools before and after the cultural material had been used.

Special acknowledgement should be expressed to each individual who participated in Project CUE. Since this is impossible, due to the large numbers that have contributed to the effort, the Department can only recognize in a general way, the help given by the United States Office of Education; the National Art Gallery; the teachers, coordinators and administrators in the thirteen project schools; the special writers and subject area supervisors; the staff of the Division of Educational Communications and the Bureau of Secondary Curriculum; and the manufacturers and producers of the media-materials used.

Lee E. Campion
Director, Division of
Educational Communications

Hugh M. Flick
Associate Commissioner for
Cultural Education and
Special Services

## Table of Contents

Page

WHY THE CUE PROGRAM IN SCIENCE? .......................................... 1

THE BODY AND ITS SENSES (Note: Sense perception is the basis of ideation. Attempts to improve it should be made at all levels.)

"The Circuits of the Senses"
  Introduction to Sensation and Perception.......................... 5
"Gateways to the Mind" ............................................... 7
"Sense Perception" Part 1 ............................................ 12
"Sense Perception" Part 2
  The powers and limitations of the Senses. The difference between sensation and perception.................................. 14
"Perception"
  How we perceive. Perception of shape, color, size, illusions...... 17
"Discovering Texture"
  Learning to Look and See. Developing Kinesthetic Powers........... 22
"Line"
  Learning to Look. The Psychology of Line.......................... 24
"Optical Illusions"
  Developing Size and Shape Perception.............................. 26

LIGHT AND COLOR

"Discovering Color"
  Learning to Look. Becoming more sensitive to color and the properties of pigments.............................................. 28
"Color-Lecture 12, Harvey White"
  Learning to Look. The properties of Light, the Spectrum and how we perceive color.............................................. 30
"Techniques of Painting"
  Learning to Look. The properties of pigments and binders, and how they look in paintings........................................ 34
"Autumn Color"
  Learning to Look. Becoming more sensitive to color in nature...... 36
"The Flaming Sky"
  Learning to Look. Observing Earth Phenomena More Meaningfully..... 38
"Color Discs-Benham's Disc" - "World Book Color, Illusions" - "Light and Gelatin Filters"
  Color illusions and Theories. Background for understanding color.. 41

SOUND

"Sound Waves and Their Sources"
  Learning to Listen. How Sound Is Produced......................... 46
"The Science of Sound"
  Learning to Listen. Becoming More Discriminating About Sound...... 48
"Listening to Good Music"
  Learning to Listen. How Musical Instruments Produce Sound......... 50
"Playing Good Music"
  Learning to Listen. Learning to Appreciate Sound in Music......... 52

## Table of Contents (continued)

THE UNIVERSE

"A World is Born"
Becoming aware of the beauty and wonder of creation of the earth... 54
"Prehistoric Animals of the Tar Pits"
Learning what the Paleontologist can tell us of the past........... 57
"Grand Canyon"
Learning to observe what rocks can tell us of the history of the earth.......................................................... 59
"The Artist and Nature"
Learning to be more observant of structure, form and pattern in nature......................................................... 61
"The Flaming Sky"................................................ 38

PLANT AND ANIMAL LIFE

"Nature's Half Acre"
Learning to observe the relationships between various forms of life - ecology.................................................. 64
"Let's Keep America Beautiful"
Learning to appreciate and conserve natural beauty................. 67
"Secrets of the Bee World"
Becoming aware of the structure of an insect society............... 69
"World of Little Things"
Becoming aware of the beauty, pattern and structure in the microcosm..................................................... 72
"Color of Man"
Becoming aware of the scientific reasons for small differences among men and realizing the essential oneness of man - anthropology.74

NATURE AND SCIENCE

"A Light in Nature"
Understanding more about the Nature of Science.................... 76
"A History of Medicine in Pictures" (Set 1)
Learning about the beginnings of medicine in magic, religion, art.. 79
"A History of Medicine in Pictures" (Set 2)
Learning how Medicine Evolved into a Science...................... 82

TIME AND SPACE

"About Time" (Part 1)
Becoming more aware of the Nature of Time and Relativity........... 84
"About Time" (Part 2)
Becoming aware that time is relative and of the limitations of our senses in perceiving time.................................... 86
"The Romance of Time Keeping"
Learning how men measured time in the past and today............... 88

Table of Contents (continued)

TIME AND SPACE (continued)

"Mystery of Time"
Learning to think about time stretching and compression through technology........ 90
"How Vast is Space?"
Becoming aware of man's relationship to the microcosm and the macrocosm........ 92
"Physics and Painting"
How scientific thought affects the way the artist expresses time, space, motion, energy, light and color........ 95

ENERGY

"Atomic Energy" - "Strange Case of the Cosmic Rays"
Note: These films provide background information for assisting the student to become aware of scientific thought expressed in art........ 100
"Art and Motion"
Scientific thought expressed in the arts........ 104

MACHINES

"Drawings and Models of Inventions of Leonardo Da Vinci"
Realizing how the study of form, pattern and structure in nature is common to artist and scientist, and the importance of artistic skills in expressing scientific ideas and conceptions........ 109
"Debt to the Past"
Becoming aware of how our progress is based on invention and thought of the past........ 112

COMMUNICATION

"A Communication Primer"
Learning to understand more about the Communication process........ 115
"Computer Speech"
Understanding more about the role of science and technology........ 119

PHOTOGRAPHY

"The Simple Camera"
A self-teaching Device for learning photography........ 121
"Color Collage"
Color and Creativity in Photography........ 124
"Mystery of Time"........ 90

"POETS AND SCIENTISTS"........ 125

# INTRODUCTION

In recent post-Sputnik years, there has been little time in the schools for the humanities. So many people seemed dedicated to the proposition that science was the answer to all their problems, that billions were spent on experiment and education in the sciences and almost nothing at all for the humanities. The thought seemed to prevail - Rembrandt and Shakespeare - what good are they? They can't put a man on the moon or money in the bank. Because science has solved so many problems, people think it can solve all problems even the social ones. Scientific solutions to human problems sound wonderful on paper but they too often lack realism. They fail to take into account human passions, prejudices, greed, fears, traditional and political realities.

We spend billions to get to the moon; and yet, we do not know how to help the thousands of persons who die agonizingly of cancer each year.

We spend hundreds of thousands to find the half life of an obscure atom, yet we cannot cure the common cold.

We test nuclear bombs to keep ahead of the Russians and expose our children to genetic deterioration.

Modern chemistry helps us raise so much food farmers are paid for not growing crops - yet, millions die of starvation annually. We spend untold sums on research in automation to put people out of work - we then spend more to keep them on relief or give them psychiatric care.

Science promises the abundant life and this we want but we need something more - we need to learn how to live the good and satisfying life - and this we can learn from the arts and the humanities.

The total measure of man must be more than scientific precision. Science gives us knowledge and power of action. It tells us what we can do - the humanities tell us what we ought to do. We must have a knowledge of science if we are to live - a knowledge of the humanities if we are to live well. The arts and humanities are less a sum of knowledge than a way of thinking and being which helps us mature, gives us values and adds new dimensions to our beings. Great scientists realize there is no dichotomy between art and science. Both artist and scientist are studying nature in their own way to give new insights to man. Forward looking educators realize that instead of stressing the memorization of facts, we need streamlined courses which are thorough in their integration of important principles and more than surface deep in their provision for education in the process of making judgments, forming values and learning to think.

Many people are beginning to think that the arts are forms of super-communication around which we can group many studies. The reason for this is - the more complicated the truth, and there are some very complicated ones around today - the more likely it is to be grasped by an experience with one of the poems or paintings or compositions of music which speak to us through the eyes, the ears, and the heart to strike responsive chords in us to help us understand the great ideas and principles of man.

Much learning goes on at a nonverbal and emotional level. Many people feel that from a study of the arts and humanities will come a knowledge of the values which have stood the test of time and which give men convictions and the courage to stand by and for them. This conviction has grown so great that the Council of Learned Societies has published a report on the Humanities. Below are excerpts from this important report which requests the establishment of a National Foundation for the Humanities. The report urges expansion and improvement of activities in the arts and humanities for the good of the national interest.

## National Report of

## THE COMMISSION ON THE HUMANITIES - 1964

> "In the eyes of posterity, the success of the United States as a civilized society will be largely judged by the creative activities of its citizens in art, architecture, literature, music and the sciences."
>
> The President's Commission on National Goals.

The humanities have played an essential role in forming, preserving and transforming the social, moral and esthetic values of every man of every age. The humanities are a body of knowledge usually taken to include the study of history literature, the arts, religion and philosophy. These studies are essential in education for the growth of the individual as a rational being and a responsible member of society.

Science and the arts are not dichotomous but are by nature allies. If the interdependence of science and the humanities were more generally understood, men would be more likely to become masters of their technology and not its unthinking servants.

Even the most gifted individual, whether poet or physician, will not realize his fullest potential or make his fullest contribution to his times, unless his imagination has been kindled by the aspirations and accomplishments of those who have gone before him. The arts and letters are therefore, where we look most directly for the enrichment of the individual's experience.

Over the centuries, the humanities have sustained mankind at the deepest level of being. In the formative years of our own country, it was a group of statesmen who fused their own experience with that of the past to create the enduring Constitution of the Republic.

During our early history, we were largely occupied in mastering the physical environment. Soon after, advancing technology put its claim on our energies. The result has often been that our social, moral and esthetic development lagged behind our material advance. We are proud of our artists and scholars and our technology, which has made their work highly available, but this is not enough. Now more than ever, with the rapid growth of knowledge and its transformation of society's material base, the humanities must command men of talent, intellect and spirit.

The state of the humanities today creates a crisis for national leadership. Many of the problems which confront the people of the United States involve the humanities. Among them are the following:

- All men require ideals and vision. Americans need today, as never before, understanding of such enduring values as justice, freedom, virtue, beauty and truth. Only thus do we join ourselves to the heritage of our nation and human kind.
- Wisdom - without the exercise of wisdom, free institutions and personal liberty are imperilled. The humanities impart insight and wisdom.
- When Americans accept their cultural responsibilities, the arts will help us understand cultures other than our own. Few people can understand a nation which spends billions on defense and will do little or nothing to maintain the creative and imaginative capabilities of its own people.
- World leadership cannot exist solely on the force of wealth and technology. Only excellence of goals and conduct entitle one nation to ask others to follow its lead.
- Greater life expectancy and automation make leisure a source of personal and community concern. The arts and humanities provide a stabilizing influence and fill the abyss of leisure profitably and enjoyably.
- The arts and humanities hold values for all human beings regardless of their abilities, interests or means of livelihood. These studies hold such value for all men precisely because they are focused upon universal qualities rather than on specific and measurable ends. They play a uniquely effective role in determining a man's behavior and values. These studies therefore should not be reserved for scholars alone but should be for all students whether they leave school after grades 9, 12, or after college or a doctoral degree. While the schools are not the only agency to accomplish this task, there is no other in America that bears so heavy a responsibility.

# USING CUE MATERIALS EFFECTIVELY

The following points are stressed to give insight into the CUE system and the utilization of CUE materials. CUE schools are supplied with packages of media described in the CUE guides. Other schools or libraries may also acquire the CUE materials from the listed producers in the back of this guide.

- CUE guides contain a wide selection of classroom tested materials related to the New York State Curriculum so that the teacher may select those which best suit the needs of his group.
- The Synopsis which is a description of each piece of material is provided for the teachers' convenience in selecting material to preview.
- Synopsis and "Suggestions for Class Preparation" provide for class orientation and motivation.
- "Look and Listen For" items point out important areas in the material. Alerting students to these items result in increased retension of important factors.
- "Follow-Up Activities contain numerous suggestions to stimulate the teachers' own creativity.
- The Related Materials listings saves teacher time in locating other sources. Librarians may wish to acquire CUE related materials for teacher and student convenience.
- A stimulating learning atmosphere is made possible through permanent and traveling exhibits of art reproductions and realia as well as performances provided by CUE. These activities serve as a unifying thread around which many student experiences may be grouped. Such beneficial unification of learning experiences may be further enhanced by:
    - occasional use of team teaching;
    - use of art and music teachers as resource persons.
- A TV program "Cultures and Continents" provided for mountain top experiences ordinarily not obtainable in the classroom. This program gives insight into non-western cultures through their arts. Large group viewing of these programs enables some teacher to have free time for mutual planning.
- Kinescope (filmed versions) of these shows are available for those schools not serviced by TV.
- Cultural organizations channel many of their services to schools through CUE.

- Business and Industry provide materials for schools through CUE. Such services are related to the curriculum in a meaningful way.

- CUE provides materials to develop abstract concepts and generalizations. Some of these materials may be seen, felt, smelled, heard, manipulated, or organized, assembled or taken apart during learning. These experiences are those which are retained and recalled and become a permanent part of the students knowledge.

- There is no substitute for teacher guidance and insight in selecting planning, organizing and using instructional materials. CUE provides the teacher with a wide choice of classroom tested, teacher certified materials which save teacher time in locating and evaluating materials and free that time for the important personal aspects of teaching.

- CUE materials are keys which open doors to new vistas of learning interest, broaden horizons and increase perception but it is still the teacher who remains THE MASTER KEY in proper selection, use and development of insights.

## The Argument for Inter-disciplinary Relationships

Too commonly, the teacher teaches his subject, or a unit within it, without reference to its relationship to other components of the curriculum. Students often study one subject after another, with no idea of what his growing fund of knowledge might contribute to an integrated way of life.

The special job of education is to widen one's view of life, to deepen insight into relationships and to counter the provincialism of customary existence; in short, to engender an integrated outlook.

The arts and humanities may be used as a unifying thread in the curriculum. This unitary view of the curriculum is important because:

- Comprehensive outlook is necessary for intelligent decisions.
- A person is an organized totality - not a collection of separate parts.
- An atomized program of studies engenders disintegration in the life of a society.
- The value of the subject is enhanced by an understanding of its relationship to other subjects.
- Knowledge does not exist in isolation; integrated subject matter is more meaningful.

# TIME TO INCLUDE THE ARTS?

Many teachers are firmly convinced of the worth of including the arts in the curriculum but profess they do not have the time to do so. The following are a few suggestions for making time available.

- Use the arts as a vehicle for subject skills.
  The study of all subjects needs a vehicle. The arts can be such a vehicle - one can learn all the techniques and skills of reading and communication while learning about the arts. Art and science are inextricably related; both are looking for sense, order, and beauty in the universe. True understandings of the people of the world cannot be grasped out of the context of their arts. Industrial arts are on outgrowth of fine arts. Homemaking involves knowledge and use of arts. The compelling reason for use of the arts as a vehicle is that students today are in dire need of acquiring a much higher level of culture than was formerly thought adequate.

- Use of large group instruction.
  Several groups may view T-V, a film or hear a lecture given by one person, thus freeing teachers for mutual planning or conference.

- Independent Study.
  Students may use filmstrips, programmed learning or do independent research on their own in study hall or learning center or library.

- After school seminars.
  On arts and humanities for interested groups.

- Use of time ordinarily not used for study before school lunch hours, home room activity periods may be used for listening to good music or other activities.

- Out of school time.
  Evenings, weekends may occasionally be used for museum or concert visits, architectural tours.

- Assembly programs may be cultural in nature. Thus large groups can be reached.

- Use of a stimulating environment.
  Students learn at least as much outside of class as in. Educational displays provided by CUE, effective bulletin board displays create an atmosphere for learning and teach students in incidental moments.

## WHY THE CUE PROGRAM IN SCIENCE?

An already overcrowded curriculum makes time to teach it all a real problem to the teacher. Then why the CUE materials? Many compelling reasons are given in the CUE Insights why inclusion of this program offers much to the student but the following are the most pertinent to the sciences:

- It is no longer possible to teach the student all the facts and skills he will need to know. Many facts and skills rapidly outdate.
- It is impossible to prognosticate the students future needs in a rapidly changing society which will demand continued learning and readjustment.
- Learning to see patterns, structures and relationships and research skills provide the student with background for lifetime learning.
- Success in the sciences as well as life depends greatly on sharpened perception, awareness and creativity.
- Sharpened perception tends to increase understanding and provide more effective communication powers; both vital to social progress and cohesion. Creativity will find solutions to as yet unknown problems of the future.

The CUE program attempts to provide experiences which will increase powers of perception and sensitivity and stimulate creativity. Some of these activities have to do with the arts but the purpose is not primarily to develop appreciation of arts and humanities but to promote heightened sensitivity to visual and other stimuli, increased accuracy of observation, an expanded range of communication skills, increased powers of observation and analysis through better interpretation of stimuli received from the environment, development of kinesthetic conception of forms, gradual development of skills in the manipulation of materials into effective communication of ideas, deeper insights, and the development of imagination and of creative ways of thinking. The development of these powers will in turn afford the student with new interests, powers of appreciation and ability to understand and enjoy life. CUE believes education is for living as well as making a living.

In order to further explain the underlying philosophy of the CUE program and its rationale for integrating the arts with science,certain thoughts gleaned from scientists, outstanding contemporary thinkers and philosophers are stated below. These thoughts come from men like Bertrand Russell, Alfred North Whitehead, John Dewey, Max Otto, Charles Sanders Pierce, Albert Einstein, Walter Lippman, Lincoln Barnett and Rudolf Carnap.

## THE IMPACT OF SCIENTIFIC THOUGHT

The influence of modern science upon contemporary life and thought has been tremendous. Since 1859 with the publication of Darwin's "Origin of the Species" modern science, technology and thought have revolutionized our lives. We take for granted what would have been considered fantastic less than 100 years ago.

Since science has solved so many problems, many people believe it can solve all problems. They are willing to consider all other forms of learning and thought as unimportant. However, great scientists are aware of the value of prerational thought.

Science helps us rid ourselves of superstitions and unreasoning prejudice. Its findings often confirm beliefs and faiths long held by man on an irrational basis. "The most beautiful and profound emotion we can experience is the sensation of the mystical. It is the sower of all true science." (Einstein.) In the light of the value of prerational or intuitive knowledge and the fact that there is much that we do not know about the universe and the learning process, it is well to bear these facts in mind:

- We are now largely an urban industrial mobile society in contrast to our rural agrarian sedentary forbears.
- Mass media, fantastic changes in transportation and communication, other technological developments are increasingly transforming our lives.
- These obvious material and physical changes are accompanied by more pervasive, if less obvious, social, moral, religious and intellectual changes.

## SCIENCE AND ARTS AND HUMANITIES ARE MUTUALLY SUPPORTIVE

- Science has had a great impact on our ways of thinking and behaving.
- The scientific point of view is so prestigious today that attempts have been made to develop a strictly scientific philosophy and morality.
- Scientific solutions to human problems are often unrealistic in that they fail to take into account human passions, greeds, prejudices.
- Scientific solutions to natural problems often cause a "kickback" by creating other problems (such as atomic annihilation) sometimes larger than the one solved.
- Science promises the abundant life - it provides power and tells us what we can do.
- The humanities and arts offer the good life - they tell us what we "ought" to do.
- There is no dichotomy between science and the arts - both scientist and artist study nature to find pattern, form, structure, sense, truth, beauty.

Scientists should be constantly aware of the sociological significance of their technological achievements. A study of the arts can alert them to human values in powerful unforgettable ways.

Insight into the truth revealed by the arts is best achieved not through a study of the arts in isolation from the rest of life and thought or by a consideration of esthetic principles and techniques alone - but rather through a consideration of these artistic principles and techniques as they are modified by the larger influences at work in the life and world of the artist.

- Revolutionary developments in the arts are dominated by the achievements of the vision of the mathematician, the achievements of the engineer; and other scientific thought and cannot be truly understood or appreciated out of their relationship to the findings of science.

In turn the works of the artist influence industry and his experiments may also influence the work of scientists. It is well to remember:

- Knowledge does not exist in isolation.
- Science extends and broadens our outward powers of perception to know physical reality.
- The arts and humanities help us refine the received data into a way of life.
- Both arts and science are important ways of learning which are mutually supportive and interactive. Both the science and art depend on increasingly refined interpretation of sensual data and use of symbolism; both vital components of creative thought.

It is well to maintain an open mind about how knowledge is to be found. No blight can so surely arrest all intellectual growth as the blight of cocksureness.

Both the arts and sciences involve creative imagination. Investigation of phenomena without imagination will not result in seeing new relations, explanations or laws or insight.

To set up a philosophy which barricades any road to further advance toward the truth is the one unpardonable offense in reasoning.

The scientist should be aware of:

- Over-confident assertion.
- Maintaining that anything can never be known.
- That any element of science is basic and independent of all else.
- Maintaining that any law has found its last and perfect formulation.
- Science is not infallible - no man of self respect ever states his result without affixing its "probable error" - in some cases the probable error is too vast to be estimated.

New findings show such deviations from Newton's idea of a machine-like universe that right now there is a question whether scientific man is in touch with reality at all - or can ever hope to be.

## SCIENCE AS WELL AS THE ARTS NEEDS CREATIVE IMAGINATION

In accepting a mathematical description of nature physicists have been forced to abandon sense perceptions. This view neglects the entire subjective world.

Since every object is simply the sum of its qualities and since qualities exist only in the mind, the whole objective universe of matter, energy, atoms and stars does not exist except as a construction of the consciousness, an edifice of conventional symbols shaped by the sense of man. Einstein showed us that even space and time are forms of intuition which can no more be divorced from consciousness than can our concepts of color, shape or size. Space has no objective reality except as an order or arrangement of the objects we perceive in it and time has no independent existence apart from the order of events by which we measure it.

Relativity and the Quantum theory rest on two entirely different and unrelated theoretical foundations. Einstein's unified field theory is an attempt to construct a bridge of harmony between them.

- Since truth and beauty are synonymous it is the vital to see the beauty of the truths science reveals.
- Since science is neutral and can be used as a power for both good and evil it is necessary to develop awareness of the sociological significance of scientific achievements and to develop a sense of responsibility for the common good.

Science has caused many to turn against the stale orthodoxy of the religion of their fathers and yet it has caused them to feel a vacancy in their lives.

Scientific explanations of reality alone cannot give men a clue to existence.

Scientific theories and facts outdate rapidly. The Darwinian theory is so greatly modified by science that some of it is almost obsolete.

## DEEPER INSIGHTS CAN BE GAINED THROUGH SEEING RELATIONSHIPS

Both religion and science are in the state of continual development. We do not go about saying that there is another defeat for science because its old ideas have been abandoned. We know that another step of scientific insight has been gained. Religion and physics must be continually modified in accordance with scientific advances. In general:

. The impact of science on moral convictions can be wholesome for as morals become infused with the spirit of science and rescued from the narrowness and dogmatism of emotion and prejudice we can hope to develop a more mature humane life.

. Therefore, the sciences can if they are taught in their fullest sense without discounting humanistic ideas and the insight afforded by the arts, help students develop not only new maps of reality but satisfactory philosophies of life which set the tone of human venture.

. Therefore, students should be encouraged to think philosophically as well as scientifically and to realize that there are different ways of thinking about sense data. Science can help us attain moral progress in a new complex world.

. Science can transfer the burden of moral life from fixed rules or pursuing fixed ends over to the detection of the ills that need remedy and formulation of plans and methods for dealing with them.

. No individual or group will be judged by whether they come up to or fall short of some fixed result but by the direction in which they are moving.

These premises illustrate that there are no dichotomies between the arts and sciences, between science and religion. Rather than being antithetical, they are mutually supportive. Deeper insights, more meaningful learning can be achieved through assisting students to understand these relationships through use of CUE and other materials.

"Those who are enamoured of practice without science are like a pilot who goes into a ship without rudder or compass and never has any certainty where he is going." Leonardo da Vinci

"The imagination voyaging through chaos and reducing it to clarity and order is the symbol of all the quests which lend glory to our dust."

John Livingston Lowes, in
The Road to Xanadu.

"As our art is not a divine gift so neither is it a mechanical trade. Its foundations are laid in solid science; and practice, though essential to perfection, can never attain that to which it aims unless it works under the direction of principle."

Sir Joshua Reynolds in his
seventh "Discourse."

CULTURAL ITEM: "THE CIRCUITS OF THE SENSES" (Flat picture or slide)
Life Magazine, June 28, 1963, page 64. (CUE Science Kit)

CURRICULUM AREA: Perception - **Introduction to Sensation and Perception.**

PURPOSES:

To explain how the nervous system is our "gateway to the world." (Note: This picture may be used as motivation for the CUE film "Sense Perception.")

SYNOPSIS:

"The Circuits of the Senses" is Part IV of Life Magazine's series, "The Human Body." It consists largely of paintings by Arthur Lidov, coordinated with text by Robert Campbell. "The Nervous System is Our Gateway to the World" shows a figure contemplating a summer night, his nervous system recording millions of sensations from his various senses. The text explains that his brain can "boil all this input down, add memory, awareness and wonderment, and come up with the single esthetic experience of a transfigured night."

SUGGESTED PREPARATION OF THE CLASS:

Give a brief explanation of the significance of the picture by discussing:

- How the network of nerves is depicted, representing the nervous system of man.
- The various surrounding objects shown in the picture, representing stimuli which affect his senses.
- The nervous system as shown reacting to the:

Sound of the church bell
Flame of a match
Light of the stars and the moon
Fragrance of flowers
Movement of the clouds

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

1. Discuss the following questions with the class as they view the picture:
   - By what means is man able to react to the rose, the bee, the burning match, and the light of the moon and the stars?
   - How does he blend these stimuli into a single feeling of well being? (Through his brain's interpretation of sensory stimuli.)
   - Why has the artist painted the objects surrounding the figure gray, and colored them only in the man's brain? (This is how his brain perceives them.)

- Do you think these objects might look the same to a bird or a dog? (We can't be sure.)
- Do colors and objects always look the same to different people? Why not? (Perception is governed by sense limitations and past experience.)
- Why do you have fear reactions when you hear a bee buzz or a snake hiss?
- Do your senses ever fool you?

2. Utilize the rest of **the illustrations in the article to further stress** the difference between sensation and perception.

3. Use CUE Optical Illusions transparencies on the overhead to illustrate to students how easily one's senses can be fooled.

4. Spin Benham's disc (in CUE Kit) and color discs on motor or pencil point to permit class to observe color illusions.

SUGGESTED RELATED CREATIVE ACTIVITIES:

The artist Lidov employs symbols and representations in his paintings to communicate ideas and concepts which couldn't be verbalized as effectively. Students could use such symbolism to summarize their learnings regarding the operation of the senses by either drawing or tracing various symbolic objects and arranging them into a pattern representing the relationship of the real world to the world as perceived by man.

RELATED MATERIALS:

Films:

Sense Perception. (Moody Institute) (2 parts)
Perception.
Gateways to the Mind. (Bell Telephone Company)
Visual Perception. (Educational Television Service)

RECORDING:

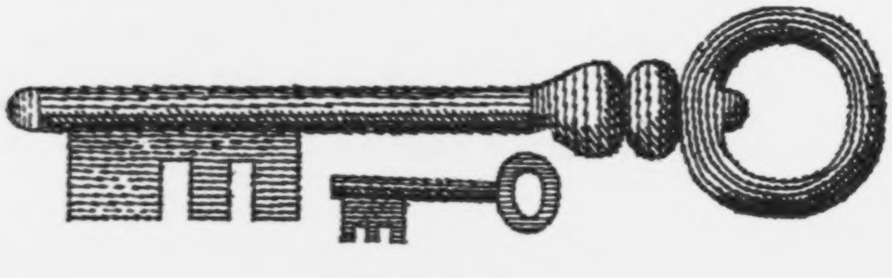
Science of Sound. (Bell Telephone Company) (CUE Science Kit)

FLAT PICTURE:

Metropolitan Seminars in Art - Perception.

ILLUSION MATERIAL:

Color Illusions. (Benham's Disc, Color Wheels, Color Illusions)



**CULTURAL ITEM:** "GATEWAYS TO THE MIND" (Film)
58 min., Color, Bell Telephone Company.

**CURRICULUM AREA:** Body and Its Senses - How Sensation Occurs.
Practical Discoveries from Basic Research of the Senses.

PURPOSES:

To alert the student to the functioning and import of the senses and their connection with the mind.

SYNOPSIS:

This color film explains the operation of the senses with diagrams, models and animation. In addition to sight, hearing, taste and smell, the feeling senses are explored, as well as related mind processes.

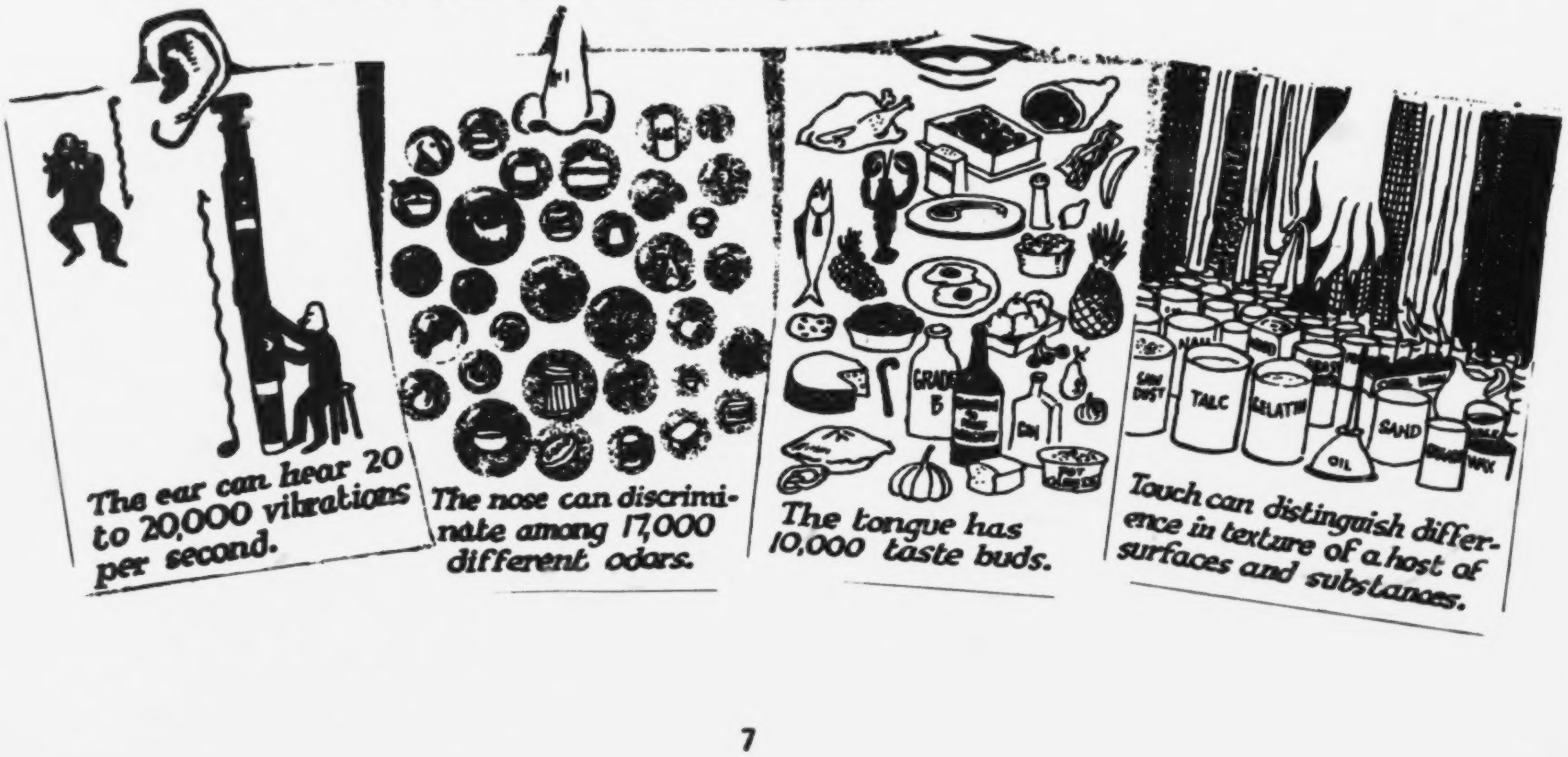
SUGGESTED PREPARATION OF THE CLASS:

To motivate students, explain:

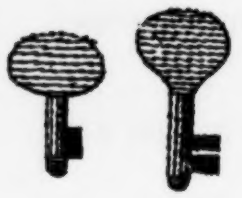
Human beings tend to take their five senses for granted unless something goes wrong with them. Scientists, however, realize that the senses are essential to the survival of the human mind.

Higher brain functions are vitally dependent on the senses. Knowing the importance, powers and limitations of our senses is vital to behavior and is an important topic of study.

A sense is a mechanism in the body which allows a human or animal to receive special information about the world and transmit it along nerve pathways to the brain. Each sense has a specific disposition. The visual sense is stimulated by light waves, hearing by sound waves, taste and smell by chemical data. (Claims to "seeing" fingertips may mean a valuable exception has been found to the principle of "specific disposition.") This film will show us how some of our senses operate.


The ear can hear 20 to 20,000 vibrations per second.
The nose can discriminate among 17,000 different odors.
GRADE B
The tongue has 10,000 taste buds.
SAW DUST
TALC
GELATIN
SAND
OIL
WAX
Touch can distinguish difference in texture of a host of surfaces and substances.

PUPILS SHOULD LOOK AND LISTEN FOR:



- The senses and how they operate.
- The group of feeling senses.
- How senses alert the brain; **how the brain reacts.**

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

To further student understanding of why study of the senses is important, explain:

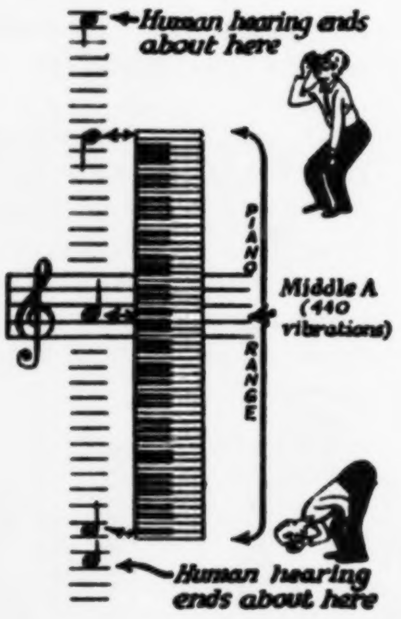
The sense powers of individual species of animals vary greatly. Whole species operate on differing channels or spectrums for each sense. Humans cannot hear mouse screams, fish calls or ultra-high frequencies. In some ways, this is a blessing. We would have no peace otherwise for the air and ocean are filled with cries and sounds.

Although human vision may appear limited compared to a hawk's, it is probably the most versatile in nature, and our ability to see color is the best in the animal kingdom despite the fact that individual animals can outdo us in some specific area.

Human hearing is powerful within its sonic band (20 to 20,000 vibrations per second). Although dogs can hear higher frequencies, our ears have a keen directional sense, and ability to distinguish individual sounds among a group.

Taken alone, taste is the most restricted of our senses. Our 10,000 taste bud receptors can distinquish only four tastes: sweet, sour, salt and bitter.

Fortunately taste is aided by our sense of smell, which needs only 1/25000th as many molecules to alert it as taste does and is also infinitely more varied in scope. The 600,000 olfactory cells can distinguish 17,000 different odors although we come nowhere near the silkworm moth, which can spot its mate by smell from several miles upwind.

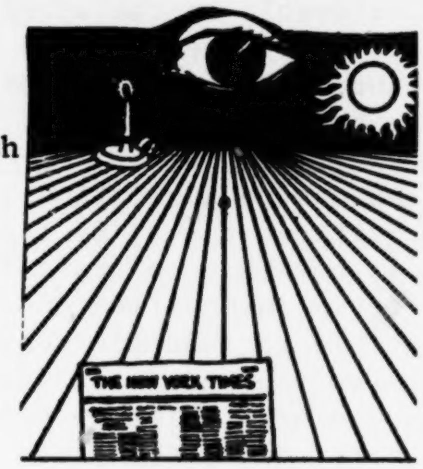

Human hearing ends about here
PIANO RANGE
Middle A (440 vibrations)
Human hearing ends about here

Although touch needs 10 billion times more energy before we can feel an object than sight needs before we can see an object, it is not a weak sense. If a pressure of 1/1000 of an ounce is applied to a hair on arm or leg it is felt. Fingertips can discriminate between smooth, wet, hard, soft, dry, slippery and sticky, and can distinguish between dozens of textures in a split second.

Formerly, we thought we had only five senses - sight, hearing, taste, smell and touch. As we gain deeper wisdom about our bodies, we are learning that there are many more human senses than the original five. Touch is one of a group of senses called feeling senses. The other feeling senses are pressure, heat, cold and pain. In addition we recognize today that hunger, thirst, muscle sense and balance are separate senses.

Although we have built-in limitations to our senses (a person with 20-20 vision can't stretch his range of sight), certain sense organs can be trained, to bring out latent qualities or to reach their true limits. Blind people develop their hearing to such an extent that they can use their "echo sense" to locate their direction and position.

Some experiments have suggested that some people may be able to "hear" or to distinguish "color" with their fingertips. Professional tasters and "noses" and "texture feelers" have developed these respective senses to a fantastic extent by constant training.



*The normal eye can see small print at inches or a grapefruit at a quarter of a mile.*

If the Barnard Russian experiments prove that mankind has some sense of sight in his fingertips this may turn out to have practical applications for the blind, and in the realms of the visual and the tactile a whole new esthetic synthesis may take place.

## What is the practical use of such knowledge as the above about the senses?

It has been found that salmon and trout react with aversion to pulsating electromagnetic fields in water. This discovery allows fish and game inspectors to herd salmon and trout into special pens while fish are migrating upstream, simply by turning a section of the river into an electro-magnetic field.

A new multi-channel radio transmitter has been suggested based on mankind's ability to screen out the voice we want to hear from a cacophony of others.

A mosquito repellent that lowers human skin temperature is based on new data, which indicate mosquitoes are attracted to those humans who have a slightly hotter skin surface.

A new system has been devised for talking with persons through wires attached to fingertips in noise filled areas or in space.

New glasses for seeing in the dark are based on the ultra-violet rays.

New photography of people that aren't there is based on taking pictures of the infra-red heat rays left in an area by a body.

Some inventions are arrived at by studying the special attributes of animals and insects.

A ground speed indicator for airplanes is based on the strange compound eye of the bee which allows him to calculate his movement over land. Until the device was invented, pilots could only tell their speed in relationship to the speed of the wind. If a plane was going 100 mph in a 100 mph headwind he had no instrument to tell him he was getting nowhere. With the ground speed indicator, he is nearly as sure-winged as a bee.

Cutaneous communication is its scientific name but they've nicknamed it "tickle talk." By taping electrodes to the fingertips of one hand, it is possible to transmit a simple code based on tingling sensations of three intensities and different finger combinations. Amazingly it is possible to teach persons to receive this code in just 12 hours and to receive the code messages faster than a Morse code expert attains in six months. This new system should be useful for "talking" to men at work ear jet engines or drop hammers. It is possible for the ear to substitute for the eye by bouncing high frequency sound signals off a radar type "dish" toward a blindfold subject in echo free room whose walls absorb all sound except the signals that strike the target and bounce back to him. He can detect cylinders the diameter of small water pipe and fence wire and tell them apart. This research may lead to advanced submarine detection sonar and evantually to a flash size magic wand for the blind.

Many practical discoveries come from such basic research.

These are but a few of the facts uncovered about the senses in the past century. The extension of this knowledge, and of practical uses for it, seems today almost limitless in scope.

Experiments have proved that when man is cut off from all sensory stimulation he soon ceases to do any concerted thinking. Sensation is the basis of perception, which in turn is the basis of all ideation, which in its turn governs behavior. The study of the limitations and powers of the senses is a vital one for scientists and students.

## Do our senses tell us the truth?

Since sensation is the basis of perception, and perception is the basis of behavior, it is important to be aware of the limitations of our sensation and perception.

Fatigue causes faulty sensation. Strong odors seem to disappear as the olfactory cells tire.

Delicate tastes vanish as the tongue becomes accustomed to them. Cold dulls taste; eye fatigue causes blurred vision.

Disease and defects affect sensation. Colds or injury affect ability to smell. Some persons are color blind. Ear infections may affect sense of balance.

The messages from our senses can be changed by our minds and feelings.

Two people seeing the same accident often describe quite different happenings. (One may be daydreaming and fail to see accurately, the other paralyzed by fear and unable to perceive accurately.)

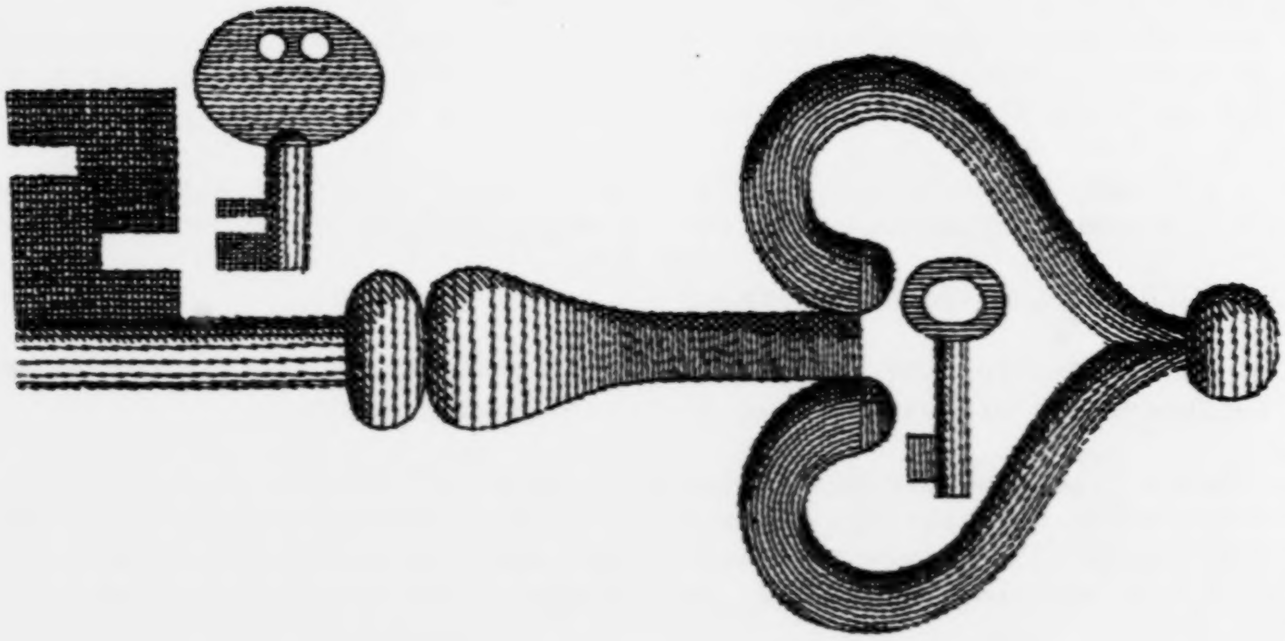
Parents of a boy playing a violin beam with pleasure, while others seem to suffer. (Parental love influences the senses.)

An artist remembers only the nice things said about his painting. (People tend to listen to what they want to hear.)

We can rely on our senses and mind only when we learn how they work. Such knowledge reveals us to ourselves and helps us understand human nature.

SUGGESTED RELATED ACTIVITIES:

- Ask students to volunteer to tell of times when their feelings or inattention interfered with adequate perception.
- Science Fair exhibits might be based on inventions based on the operating principle of some special attribute of an animal or insect, or on explaining how these special attributes function.



CULTURAL ITEM: "SENSE PERCEPTION" (Film)
27 min., Color, Part one and Part two, Moody Institute of Science
CURRICULUM AREA: Perception - **Powers and Limitations of the Senses. The difference between Sensation and Perception.**

PURPOSES:

To prove that while sensation is the basis of ideation, perception does not occur within our sense organs but within the brain.

To alert the student to the necessity of understanding more about perception and to help him incorporate this knowledge into future behavior as a result of perception.

SYNOPSIS:

(Note: If time is short, show only part II of this film. Relay information in this synopsis to students.)

The "windows of our souls," the five senses, are explored. The viewer learns that sense perceptions occur in the brain; the narrator is chosen to participate in an experiment to prove this statement. For several weeks he wears eyeglasses which make everything look upside down. His brain subsequently adjusts the image so that he is able to engage in normal activities, such as walking to work, and in dramatic test situations, such as riding a motorcycle and flying an airplane. When the upside-down eyeglasses are removed, he still "sees" upside down, proving that his sight perception is dependent on his brain's perception. The eye is researched further. The blind spot is illustrated as it actually appears in our vision; the 137 million rods and cones are revealed and explained with the aid of a diagrammatic cross-section.

A model of the ear is utilized and the individual parts are studied with the emphasis on the cochlea, that magnificent reproducer of all the sounds we hear. A sensitive odor-detecting device, consisting of fine powder sprinkled on mercury, provides us with some artful creations as the molecules leaving various odorific substances push aside the powder in beautiful patterns. We learn that the olfactory nerves in our noses are at least one hundred times more sensitive than this device.

A baseball outfielder's actions are analyzed through slow motion diagrams to provide an opportunity to see in operation the senses we have studied.

SUGGESTED PREPARATION OF THE CLASS:

Motivation for the study of the senses and their limitations may be heightened by discussing some of the following points:

. Man's brain and nervous system are among the true marvels of the universe. The brain can take all the sensory stimuli fed into it by the sense organs, millions of messages per second, and make sense out of all these signals. It can associate, remember, have inspirations beyond the reach of the most complex computer. Yet, unless we are trained to perceive widely and accurately, we can misinterpret the signals sent to the brain. It is important, therefore, to know the limitations of the senses, since all we know of reality we learn through these receptors. There is great probability that there is much more to perceive than we have experienced.

- Because the upside-down eyeglasses experiment is highlighted in the film, the students should possess the prior information necessary to appreciate the experiment and its outcomes. The inverted image of a simple camera, or a chalkboard illustration of one may be utilized to provide the students with the knowledge that a double convex lens, such as the eye lens, will invert an image.

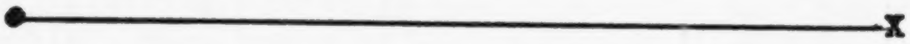
## PUPILS SHOULD LOOK AND LISTEN FOR:

- The preparation which had been done before conducting the inverting eyeglasses experiment.
- The unexpected outcomes of the experiment.
- Why it might have been disastrous if the inverting spectacles had fallen off during the motorcycle or airplane tests.
- How our brains fill in our always-present blind spot.
- The beautiful patterns formed by odors on the odor-detecting apparatus.
- A baseball outfielder's senses in action.

## PRESENT MEDIA.

## SUGGESTED FOLLOW-UP ACTIVITIES:

1. The pupils can attempt to find their blind spots by drawing a circle, dot, "x" and line as follows:



Instruct them to close their left eyes and stare at the dot, about ten inches from it, with their right eyes. By moving their heads up or down, they will notice that, at some point, they will no longer see the "x" with their peripheral vision, but will see the line extended through the space where the "x" was. The image has fallen upon the area of the eye which has no light receptors, so the brain improvises.

2. Show Part II of Sense Perception.

3. Use CUE optical illusion transparencies and lesson. (Note: The most important part of this lesson are the follow-up activities in Part II.)

## SUGGESTED RELATED CREATIVE ACTIVITIES:

Youngsters may wish to construct an odor meter like the one shown in the film. Photographs of the patterns of various odorific substances can be displayed.

## RELATED MATERIALS:

Film:

Sense Perception. (Part two) (Moody Institute of Science)

CULTURAL ITEM: "SENSE PERCEPTION" (Film)
27 min., Color, Part two, Moody Institute of Science

CURRICULUM AREA: Perception - **Powers and Limitations of the Senses.**

PURPOSES:

To utilize the learnings in Part one for a further venture into sensory perception.

To enable the student to appreciate the limitations of the senses in the perception of the universe and to prepare him to incorporate this realization into future perception and behavior (which is the result of perception).

SYNOPSIS:

(Note: If time is short use only Part two of film. Tell students of the experiments in Part one, see synopsis).

After a brief summary of the conclusions of Part one, the student is introduced to the infinitesimal sections of the spectrum that humans can perceive. Newton's prism disperses white light to provide a view of the wave-lengths of light we see as colors, in contrast to the longer wave-lengths of electric waves, radio and radar, which our senses cannot detect. We see the red of molten steel, and perceive the infra-red as heat. We are unable to see ultra-violet until its wave length is increased by being reflected from certain minerals.

A dog whistle is employed to demonstrate the upper frequency limits of our range of hearing. An ultrasonic dishwasher is representative of the many applications of high frequency sounds we cannot hear. Blindfold tests prove that our sense of taste is largely a matter of smell.

Interesting optical illusions (a rotating trapezoid, an illusion room) provide examples of our eyes "telling the truth, but our brain refusing to believe it." The age of science is explained as having been initiated when dependence on the senses was replaced by the use of instruments. The necessity of moral and spiritual values in this period of explosion of scientific knowledge is stressed.

SUGGESTED PREPARATION OF THE CLASS:

- The teacher can introduce students to the concept that our sense of sight can detect only a very small part of the electromagnetic spectrum by drawing a wave-length or frequency scale, indicating radio waves, infra-red waves, visible light, ultra-violet, X-rays, gamma rays and cosmic rays, emphasizing the very narrow band of colors that is visible light and the possibility of other waves far beyond the scale which may exist in the universe.

- "Frequency," Band 2 of the "Science of Sound" recording, demonstrates the range of human hearing (20 to 20,000 cycles per second) with the aid of a sweep tone. This could be used effectively to prepare students for the Galton dog whistle demonstration in this film.

PUPILS SHOULD LOOK AND LISTEN FOR:

- The fluorescence of certain minerals when they reflect ultra-violet.
- Our inability to hear the Galton dog whistle and the ultrasonic loudspeaker.
- How ultrasonics can drive a corkscrew through glass.
- The sensitivity of the Cecropia moth's antennae and the bloodhound's nose.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

1. Related areas can be introduced through a discussion of the following questions:

    - How is the meaning we attach to stimuli affected by our experience?
    - If we are more aware of our sensory limitations, in what ways would this affect our judgment and behavior?
    - How would realizing that people perceive things differently help you to understand and get along better with others?
    - How is technology contributing toward strengthening our perception of reality?

2. Through discussion, bring out that man has always sought to extend control over his environment; machines which man has invented - such as the lever, the wheel, the pulley, the screw, and engines - are extensions of man's muscle power. Other technological inventions extend the power of man's senses; for example:

    - The telescope and microscope extend visual power.
    - Radar and sonar extend hearing.
    - Microphones and radio extend the voice.
    - Computers are extensions of brain power in certain areas of communication.
    - Radio, television and Telstar widen man's areas of communication, and will make it necessary for man to communicate effectively with peoples of different experiential backgrounds. Therefore, it is well to know as much as possible about perception and communication in order to interpret stimuli and messages effectively.
    - Language is a symbolic means of communicating ideas; as art is a symbolic means of communicating feelings. Of course, this does not mean that language cannot communicate feelings or that art cannot communicate ideas but that art can convey feelings and ideas which cannot be conveyed verbally.

- One or more of the demonstrations in the film can be repeated in the classroom to reinforce learnings and to stimulate in-depth study.

  a. Newton's prism
  b. Fluorescent minerals
  c. Galton dog whistle
  d. Blindfold test for taste and smell perception

RELATED MATERIALS:

Film:

Sense Perception. (Part 1) (Moody Institute of Science)

Color Illusions:

| | |
|---|---|
| Benham's Disc. | (CUE) |
| Color Wheels. | (CUE) |

Projectuals and magazine reprint:

CUE "Optical Illusions".

Flat prints:

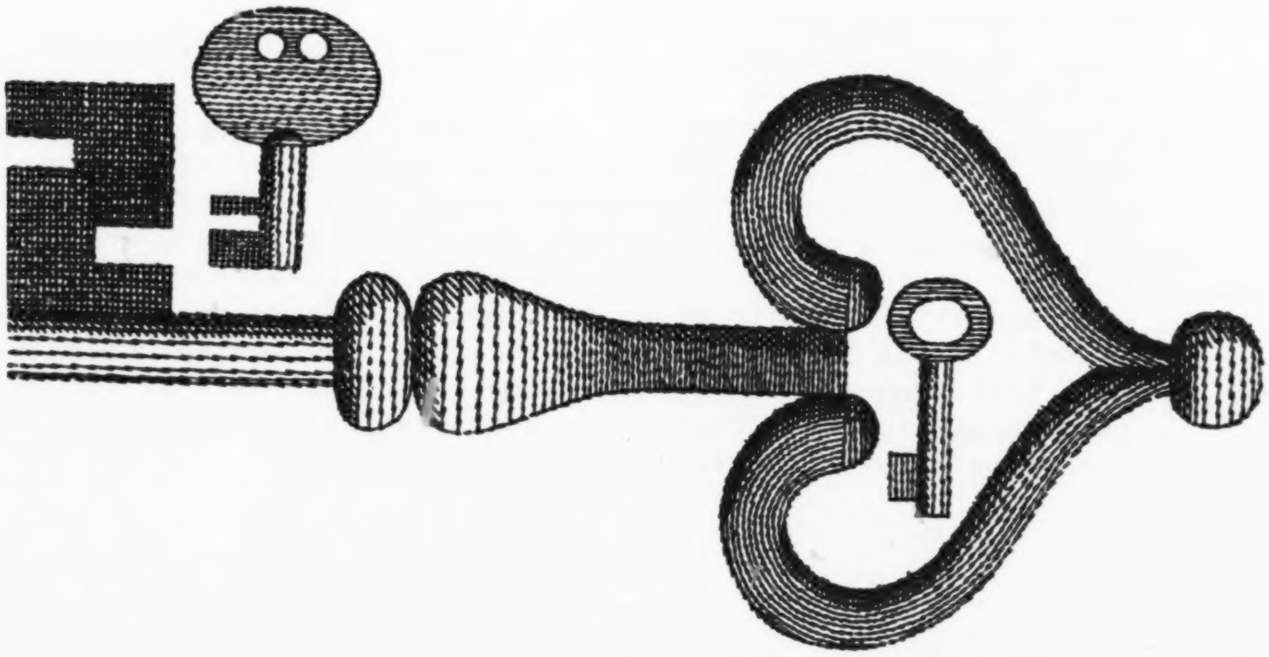
Metropolitan Seminars in Art, Portfolio III, Plates 25,31,34.

Flat pictures:

The Circuits of the Senses. (Life Magazine, June 28, 1963, page 64.)

Recording:

Science of Sound. (Bell Telephone Company)



CULTURAL ITEMS: "PERCEPTION" (Film)
18 min., B & W, MaGraw Hill Films.
"CUE PERCEPTION OF SHAPE TRANSPARENCIES."
CURRICULUM AREA: **How we perceive**
**Perception of the shape, color and size.**

PURPOSES:

To alert the student to the way in which he perceives and thus to illuminate for him his own perceptual behavior processes.

To assist students in understanding the process of perception.

To assist them to understand why they perceive things as they do **as well as** the importance of line in composition and perspective and in the enjoyment of art.

SYNOPSIS:

This film along with the accompanying CUE transparencies can give a student valuable insight into what perception is and how he perceives. Various optical illusions are shown and explained, and insight is given into why we often do not perceive correctly.

SUGGESTED PREPARATION OF THE CLASS:

Since all persons behave in accordance with their perceptions, and since scientific advances are dependent upon keen perception, it is well worth while to spend some time assisting students to gain insight into how they perceive.

Utilize the CUE transparencies to build up interest and background for film, or project illustrations from this guide.

To assist the class to understand the process of perception, explain:

When we look at the world around us, those parts toward which our gaze is directed reflect light to the eyes which comes to them from the sun or other source of illumination. This light varies in wave length, and the wave length of the reflected light varies also, producing the variations in color of the objects. The brightness of these objects also varies with the brightness of the light falling on them and the reflecting power of their surfaces. The light which reaches the eyes is focused by the lens on the retina. The cells of the retina react by initiating nerve impulses in the nerves of the eye, and these are conveyed by the optic nerve to an area at the back of the brain called the occipital area of the cortex. We tend to think that a picture of the external world falls on the retina as on a camera film, but what in fact reaches the brain is a pattern of nerve impulses, the frequency of which corresponds more or less to the brightness of the light reaching the eye. The point of the brain surface stimulated corresponds to the point excited in the retina. Differences of wave length in the light striking the eye are perceived as differences of color. If we could see the visual pattern created in the brain, it would be more like an abstract picture than objects in the world around us.

Between the projection of this visual pattern on the brain and our full consciousness of the world of objects, elaborate mental processes take place which convert the visual pattern into the perception of the world as we know it.

The visual pattern in our brain flickers and is in motion as we and as things in the environment move, and as the light changes. The impression of the continuing identity of objects, their steady and motionless position in space is something that arises within the brain itself. Even the shape of an object may vary as we see it in different positions. From overhead a plate is round; it is elliptical when tilted sideways - but we see it as the same plate. A fire box appears purplish under the bluish artificial light but we do not think it has changed. These changes do not destroy our identity of the objects nor even greatly effect how we see them.

## What governs perception

We tend to see what we expect to see. Perception is governed by past experience.

## Figure and ground

Whenever we look at objects they seem to be demarcated from the background. Ordinary objects are at different distances and we see the closest one first but even when demarcations are on a flat surface one part will stand out from the remainder. Usually the darker part will stand out but the experience of a part standing out will be stronger if the first part has some meaning or interest for the observer, especially if he sees a real object of some kind. This is called the figure ground experience which is fundamental to perception.

*The Perception of Shape by Adults*

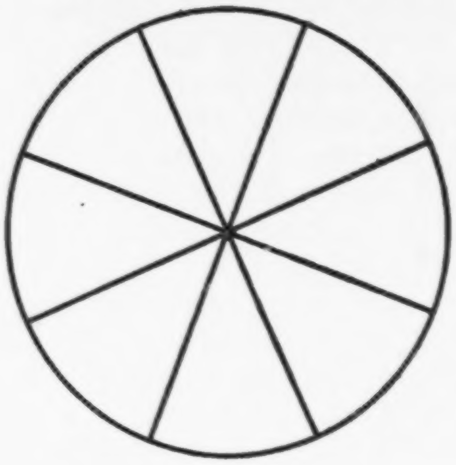
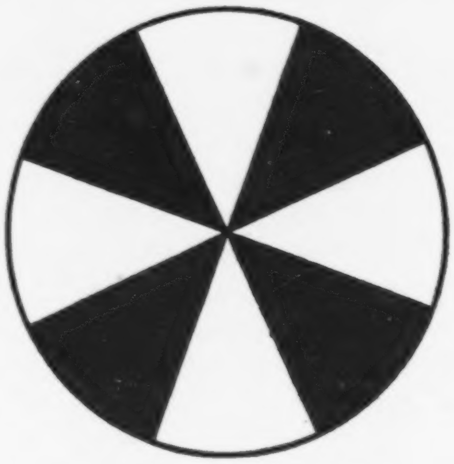
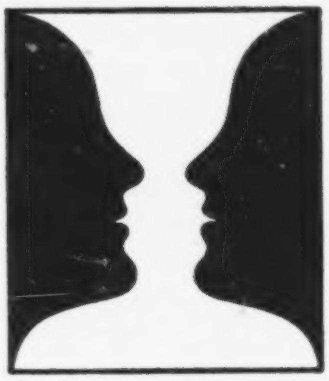


Figure 1



2. Alternating 'figure' and 'ground'

Figure 2



3. Alternating 'figures'

Figure 3

This 'figure-ground' experience is apparently mental in perception. It occurs at an early stage in developing perception, when the shape of the field begins to emerge in consciousness.

We tend to simplify complex shapes into simpler ones.

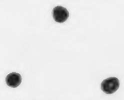


Figure 4

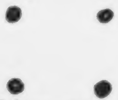
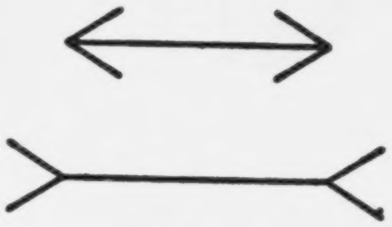


Figure 5

These dots are usually perceived as a triangle and a square.

We are influenced by surroundings;



it is difficult if not impossible to estimate the lengths of the two lines independently of the arrow heads which form part of the same figure

Figure 6

In figure 7 it is difficult to see the simple figure in the complex one.

In figures 8 and 9 a shape may be altered even by the background on which it is superimposed.

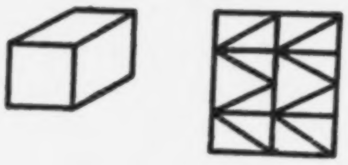
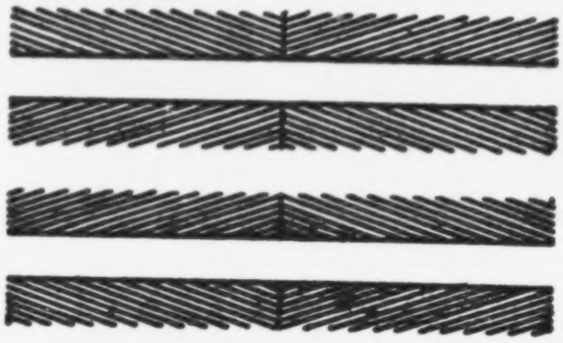
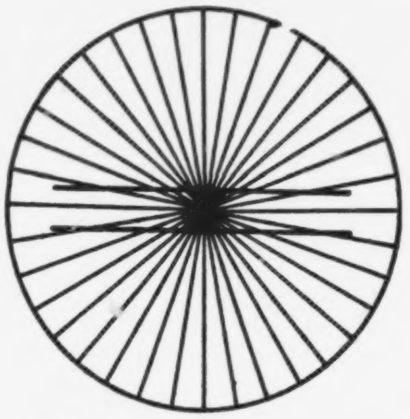


Figure 7



the horizontal lines are actually straight and parallel, but because they are combined with the oblique lines, they look curved.

Figure 8



Effect of background on figure

Figure 9

Figures 10, 11, or 12 are three views of the same complex solid. When shown these views, people do not realize at first that it is the same object from different views since it is a strange object to them. It is only after seeing it several times from different views that they grasp the idea. This is roughly the experience we go through in learning to perceive objects as a child.

When viewing this object from the front viewers tended to think of it as a complete sphere even when they were allowed to touch the flat back. (Figure 13)

*The Perception of Shape by Adults*

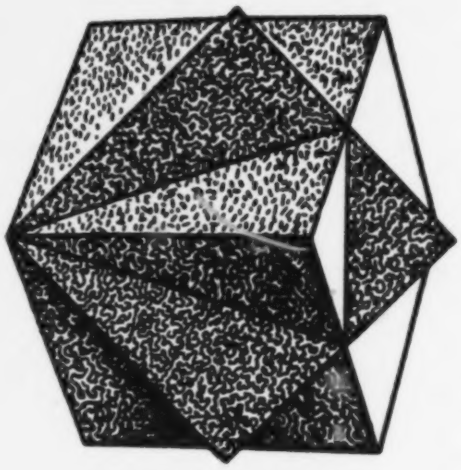

Complex solid: first view

Figure 10

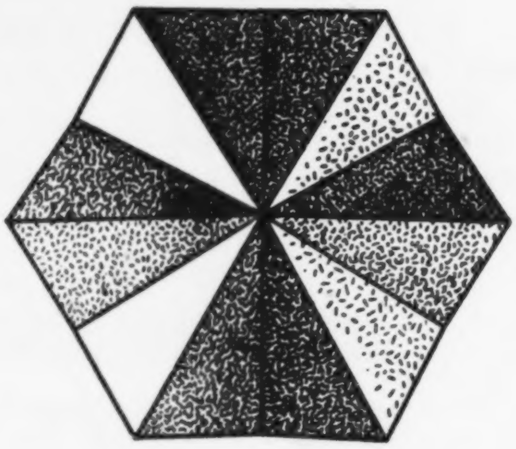

Complex solid: second view

Figure 11

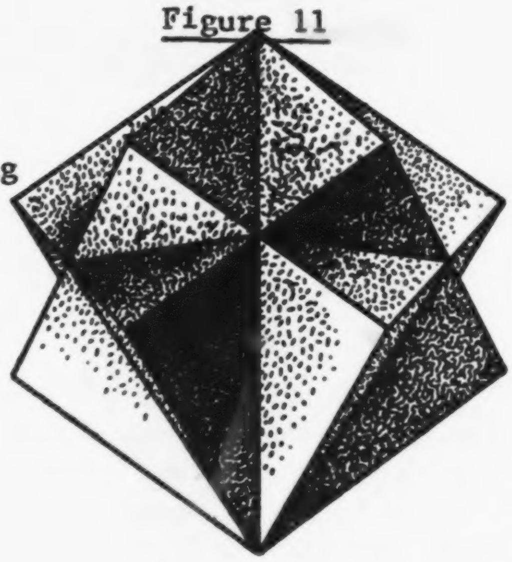

Complex solid: third view

Figure 12

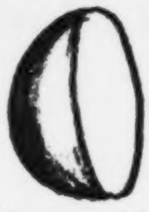


Figure 13

We tend to perceive things as we know them. In perceiving drawings, we follow the conventions in our society as to how solid objects should be represented on a plane surface. The artist learns if he draws certain lines on paper they will convey the appearance of certain solid objects which have become associated with them through conventions in drawings. He constantly uses optical illusions of color, line and form to produce depth movement and direct the eye of the observer through the composition. Because we have learned these conventions, we recognize these objects even in caricature. Yet we scoff at the conventions of earlier societies, such as the flat representations of the Egyptians or the Bayeux Tapestry. They are no more unrealistic than our fashion drawings. African tribes which do not have realistic art like some of ours find difficulty in recognizing or understanding our pictures and statues.

When seen from a plane, cars and houses are tiny and men look like beetles. It is only by a process of reasoning that we can identify what they are.

We have a special word for the process of becoming aware of all the things and events around us. It is called perception. It is an elaborate process by which we organize our sense impressions into clear and meaningful experiencing of the objects and events around and inside us. Perception involves many factors beside the sense organs. This film will tell us more about those factors.

KEY WORDS:

| | | |
|---|---|---|
| Perceptual | constancy | contrast |
| expectancy | trapezoid | stimuli |

PUPILS SHOULD LOOK AND LISTEN FOR:

- What is perception?
- Why an object seems to maintain a constant shape and size even when viewed from different angles.

- Why an object seems to remain the same color even when we see it in varying amounts of light.
- Why an object seems the same size to us whether it is close or far away.
- How we can concentrate on just **one thing even though there are many stimuli** about.
- What causes an activity or a thing to be noticed.
- Why we sometimes do not perceive correctly.
- Why we tend to see familiar shapes or continuations of lines that are really not there.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

1. The teacher may wish to discuss the following:

   - How does perception differ from mere sense impression?
   - Discuss these principles of perception:

| | |
|---|---|
| Shape constancy | Size constancy |
| Brightness constancy | Attention |
| Contrast | Expectancy |
| Figure ground perception | Grouping |

2. Have some students experiment with plate, picture boxes or other familiar objects to note the principle of shape, size, brightness, and **color constancy.**

3. Use the Optical Illusion transparencies in the Science Project CUE package to further prove how senses can be inaccurate.

4. Some students may wish to perform **sleight** of hand tricks or make their own optical illusions.

5. Show the Project CUE film "Line" which further illustrates the principle of expectancy.

6. Study prints from the Metropolitan Seminars to illustrate how the artists uses line in his compositions to lead our eye through them. Ask the art teacher to collaborate on this activity. Ask her to discuss: The "eye path" in a picture and how the artist uses line and color to lead us through the picture. How line can show size and give the illusion of distance through perspective.

RELATED MATERIALS:

Films:

Line.
Space. (Bailey Films)
Gateways to the Mind. (Bell Telephone Co.)

**CULTURAL ITEM:** "DISCOVERING TEXTURE" (Film)
17 min., Color, Film Associates of California

**CURRICULUM AREA:** Perception - **Developing Kinesthetic Sense.**
Light
Sound

## PURPOSES:

To develop perception through creating an awareness of the significance and beauty of texture in natural and man-made things. When tactile sense is developed to a high degree, visual perception is strengthened.

## SYNOPSIS:

We embark upon a photographic survey of many kinds of natural textures and learn that our sense of sight, as well as our sense of touch, perceives texture. The way light is reflected from an object determines its textural appearance. Methods of creating and changing textures are demonstrated. A photograph of the moon, highlighting the topography, points out the importance of texture to photography and space science. The significance of natural and man-made textures in sculpture, ceramics, painting, clothing and architecture is clearly established through artful examples in each field.

## SUGGESTED PREPARATION OF THE CLASS:

To alert students to textural perception, assemble bits of wood, bark, glass, velvet, sandpaper, sculpture, minerals. Put these in a box with a hole large enough for the arm to extend through. Have students feel these materials and identify them without seeing them.

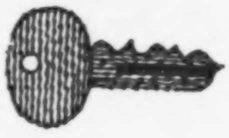
Explain: Texture is the surface quality of an object. When we feel soft velvet or rough bark, we see these objects more clearly because our sense of touch helps us improve visual perception. Smooth objects reflect light and appear bright and shiny to us. Rough textures, such as bark, absorb much light and break it up into a pattern of values of the color of the object.

## PUPILS SHOULD LOOK AND LISTEN FOR:

- Ways in which we learn about texture.
- Varieties of beautiful texture in nature and man-made articles.
- Part played by light in producing the appearance of texture.
- How different textures may be produced.
- How photography and our tactile sense helps us see textures we might otherwise overlook.

## PRESENT MEDIA.

## SUGGESTED FOLLOW-UP ACTIVITIES:



1. Observe objects in the display in the light. Explain the textural appearances of each on the basis of reflected light.

2. Distribute mineral samples. Assist students to understand the role of "feel" in mineral identification.

3. Texture is relative to magnification. To prove this, students may be asked to write a description of some smooth silk cloth. Then the same cloth can be examined under a hand lens or microscope and the descriptions revised accordingly.

4. Discuss:

   - The necessity for standardization of textural terms in the science of mineralogy.

   - The rough appearance of some acoustical material due to its similar reflection of light as well as sound.

5. Secure; display Metropolitan Seminar Prints Portfolio 1, Print 5 Woman with Chrysanthemums, by Degas; Portfolio 2, Print 13 Old Violin, Hartnett; Portfolio 2, Print 25 Starry Night; National Gallery Reproduction, Still Life with Knife, by Braque.

   - Print 13, Old Violin. Point out that this is the realistic way of rendering texture in art, by painting high lights and shadows. The viewer gets pleasure from this rendition of texture. Many Renaissance artists took pride in showing their skill at rendering beautiful silks, satins, furs and tiniest details of hair and lace. When photography freed the painter from this slavish copying of nature he used paint in built-up texture to catch light, throw shadows and provide surface interest.

   - Print 25, Starry Night. Expressionist painters like Van Gogh used texture as a means of expressing their intense emotions. Their paintings were designs in line, color, texture and space.

   - Still Life with Knife shows how Cubist painters used sand in their paint and actually scratched the surface of the paintings for textural interest and expressive effect.

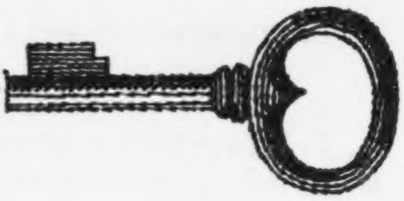
6. Ask students to especially observe textural effects in paintings and in nature and report on their findings.

SUGGESTED RELATED CREATIVE ACTIVITIES:

- Photography hobbyists can be assigned the task of demonstrating the importance of lighting in the appearance of texture. For example, the apparent texture of leaves can be altered by various lightings, as shown in "Autumn Color" (see "Related Materials").

- Students may photograph interesting textures in nature and combine these with music narration as a camera club activity.

**CULTURAL ITEM:** "LINE" (Film)
11 min., Color, McGraw-Hill Film Company.



**CURRICULUM AREA:** Physics - How we perceive line.

**PURPOSES:**

To show the relationship between the laws of nature and line as used in art.

To increase student awareness of how what he sees affects his thinking and feelings.

To develop a sensitivity to beauty of line.

**SYNOPSIS:**

This excellent film explains the psychological aspects of line and its interpretation, and assists the viewer to be more aware of the line in nature and art. Interpretations here are largely like those of Gestalt psychology.

**SUGGESTED PREPARATION OF THE CLASS:**

To prepare the class for ideas to be presented in the film, explain: Lines both in art and nature have a psychological effect on us. Whether we know it or not, we are affected by them but it is much more interesting if we know why we are affected. This film can help us understand more about line.

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- Ways in which motion is implied by the attitude of a line.
- Ways in which motion is implied by line curvature.
- Use of lines to lead the eye through pictures.
- Use of line to guide attention to the center of interest in a picture.
- Movement portrayed by association.
- Our tendency to interpret dots as lines or groups.

**PRESENT MEDIA.**

**SUGGESTED FOLLOW-UP ACTIVITIES:**

1. To further clarify, discuss with the class:
    - Why do diagonal lines tend to disturb us? (We expect motion to occur because the line is not balanced. There is a similarity here to the center of gravity principle which directly or indirectly influences our thinking.)
    - How does an artist portray movement in a picture? ( He uses lines suggesting waterfalls, waves, billowing clouds, which immediately imply motion to us.)

- What feeling of motion do we get from a horizontal line? (Since we normally read from left to right a horizontal line gives an impression of movement to the right unless it is stopped by an opposing line.)
- How do curved lines give us the impression of motion? (Our familiarity with billowing smoke or an arched bow tend to create a feeling of motion in the direction of the bulge in the curved line.)
- The emotional quality of line and how we react to it. Straight vertical lines express stability, **strength and** activity - they have force and strength enough to keep erect. Horizontal lines suggest response and calmness. When we see the horizontal lines of sea and beach we too wish to lie down. Diagonals and zigzag lines express action and excitement. They make us feel tense and involved.
- Wavy undulating lines set up feelings of gentle motion in us. Spirals tend to make us feel all wound up or compressed.
- Quality of lines;thin fine lines express delicacy and beauty. Heavy thick lines express strength and boldness. Accented line is more interesting and suggests form.

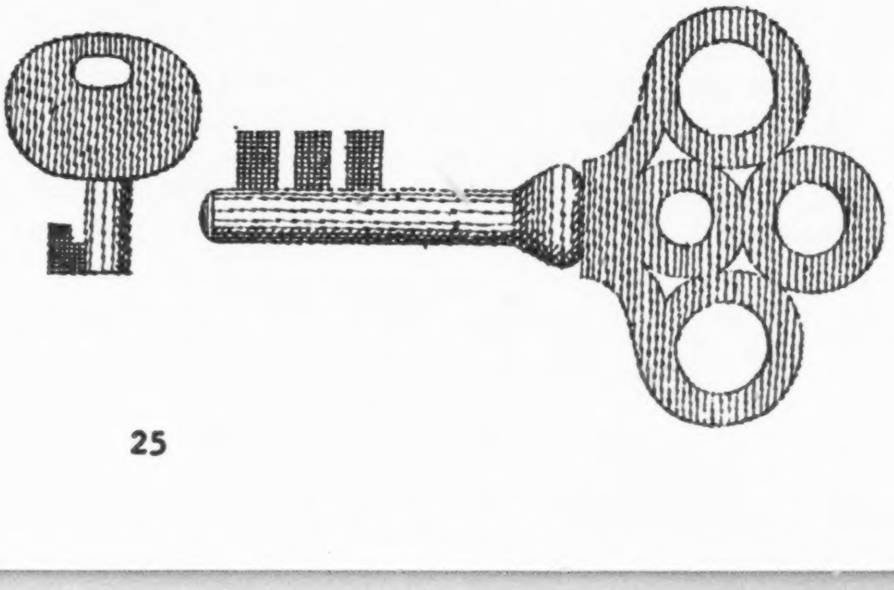
2. Secure and display Metropolitan Seminar prints and explain line as used in composition.

   - Part 6 - Print 61 - Leonardo da Vinci's Last Supper. Note how all perspective lines and figure lines lead to the head of Christ.
   - Print 65 - Martyrdom of St. Sebastian. Note how the figure lines form a triangle with the head of the martyr at the apex. The artist uses this pyramidal form to lead our eyes to the center of interest.
   - Print 63 - Rape of Sabine Women - Poussin; print 71 - Raft of the Medusa - Gericault; print 72 - Abduction of Rebecca - Delacroix. Note how the diagonal lines, spirals and swirling drapery as used by these painters set up a feeling of emotion and excitement.
   - Portfolio 3 - Print 25 - Starry Night - Van Gogh. Note how this painter expresses his intense emotion in swirling lines.

3. Ask students to note their reactions to lines in other paintings. Ask students to look for line in nature - waves, tree branches, waving grain and **grasses,veins** in leaves, lines in snow from tire treads or chains, picket fences, venetian blinds, fabrics, drapery, structural steel framework of buildings or machines, grain in wood, vapor trails, line in motion in waves and animals.

SUGGESTED RELATED CREATIVE ACTIVITIES:

Camera fans may make slides of line in nature.



CULTURAL ITEM: "OPTICAL ILLUSIONS" (Transparencies)
In Project CUE Science Kit.

CURRICULUM AREA: Body and Its Senses - **Developing Size and Shape Perception.**

PURPOSES:

To alert students to the necessity for accurate observation, perception and measurement in science.

SYNOPSIS:

These transparencies contain optical illusions related to materials which are observed and reported on in the sciences. This lesson serves to illustrate how errors in perception arise through faulty perception and faulty psychological interpretation.

SUGGESTED PREPARATION OF THE CLASS :

To help students understand why training in accurate visual perception is necessary explain: Accuracy of observation is vital for scientific investigation. Often errors in perception arise through faulty interpretation of data. These optical illusions will alert us to ways in which such faulty psychological interpretations arise.

Mask all but one transparency at a time and explain:

Although these lines are the same length, most observers will say the vertical line is longer. In the lower figure (figure 1) the vertical line has been drawn to look equal to the horizontal line. Measuring will prove it is actually a good deal shorter. This illusion is due to the fact that the horizontal line has been cut in half which makes it appear shorter than it is.

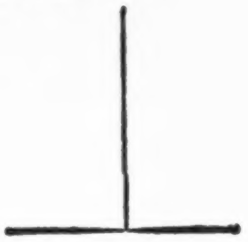


Figure 1

Examine the gentleman with the side whiskers; despite its looks, the drawing is as wide as it is tall (figure 2). The gentleman's hat brim equals the height of the hat (figure 3). Why do we underestimate the width of the portrait and the hat? In both cases our eyes are drawn to the strong tall central features and ignore the weak wings (brim of hat, **side whiskers**).

What is the use of this knowledge to a scientist? This very illusion causes continual visual underestimation of the width of the photographic line in a spectroscope. Determination of the width of spectral lines plays an important part in many scientific investigations. It was the way by which temperature was evaluated in the ZETA experiments with nuclear fission.

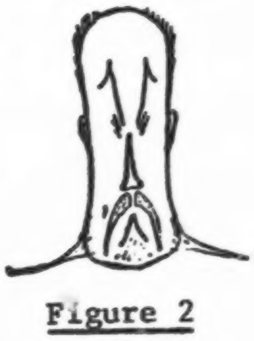


Figure 2

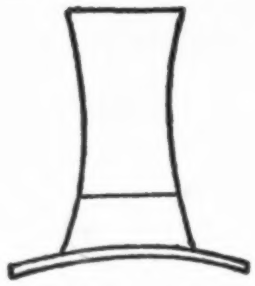


Figure 3

The convergence-divergence illusion makes this figure 4 appear shorter than figure 5 because the end lines draw our eyes inward and outward. In this figure 6, the end lines pulling our eyes outward make the indentation seem much wider than half the length of the outside lines.

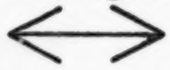


Figure 4

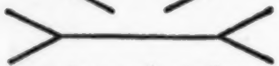


Figure 5

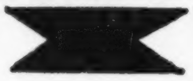


Figure 6

In this illusion, (figure 7) the body of the bug appears to taper at the ends. In actuality it is rectangular. The convergence-divergence mechanism makes the lines appear longer in the center and and shorter at the ends as our eyes are pulled in by the bent lines. Here optical illusions may set a trap for the biologist and cause errors in assessment up to 25%.

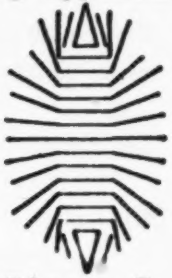


Figure 7

This illusion (figure 8) shows how difficult it is to compare two areas which differ markedly in accessory detail such as spotted and unspotted areas on a ~~subject.~~ Although the small square looks larger than the empty square, they are the same. The empty angle (figure 9) on the right looks larger than the filled-in angle on the left, yet they are the same.

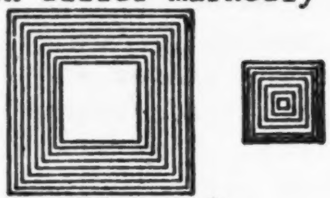


Figure 8

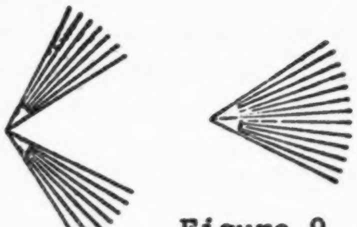


Figure 9

In Physics in working with lenses and concave or convex mirrors, it is necessary to estimate the curvature of arcs. In this illusion (figure 10) the small arc appears to have a long radius of curvature, while the big arc seems to have a smaller radius of curvature. Actually all three arcs are parts of the same circle.

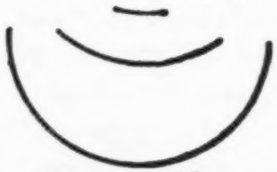


Figure 10

Thought it seems impossible the three lenses below (figure 11) have a common radius of curvature.

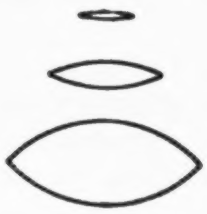


Figure 11

Believe it or not, or not, the curved arcs at the wide and narrow ends of this seashell (figure 12) both have the same radius of curvature. This would trick a scientist not fully awake to the devastating effect of short arcs.

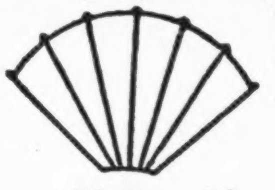


Figure 12

In the star illusion (figure 13) the length of any one of the diamond shapes is exactly equal to the distance between the lozenges and the nearest tip of the central star. Factors of irradiation (a small white square inside a black square looks larger than an identical black square inside a white square), convergence, and divergence act together to cause this illusion. Many such spot patterns turn up in optics, and in work employing x-rays for crystal and metallurgical analysis and in biological studies. These illusions point out the necessity for always making measurements in interpreting them.

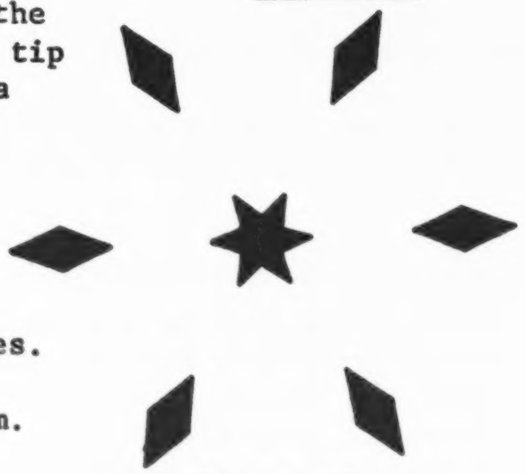
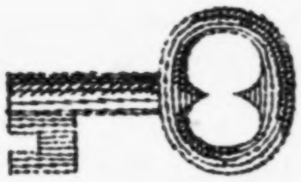


Figure 13

**CULTURAL ITEM:** "DISCOVERING COLOR" (Film)
Film Associates of California
16 minutes, Color.



**CURRICULUM AREA:** Science-Energy, Communication.
The properties of pigments - Becoming more sensitive to color.

**PURPOSES:**

To provide knowledge of primary, secondary and tertiary colors, hues and tints and how they are mixed.

To foster an awareness and appreciation of colors in environment.

**SYNOPSIS:**

This film is a visual delight. The spectrum of hues is examined through excellent motion photography of various pigmented fluids and materials, accompanied by appropriate music. Dark and light values and dull and bright intensities are demonstrated. The warm colors (red, orange, yellow) are contrasted with the cold (green, blue, violet). Some results of color-mixing are illustrated, as well as variations within individual colors. We see how various combinations of primary hues (red, yellow, blue) can produce secondary hues (orange, green, violet) and in-between hues. Beautiful color photography of natural scenes provides striking examples of color variations.

**SUGGESTED PREPARATION OF THE CLASS:**

To enable students to understand that white light is a mixture of several colors, the teacher might demonstrate how a glass prism can diffuse white light into the spectrum of the rainbow. To awaken students to the large part color plays in their life, tell them, "Color is everywhere in our lives; it is almost always affecting us psychologically. To really enjoy and appreciate color fully, we should understand something about pigments and how they function." Point out:

. The three principal ways in which colors differ.
. The primary hues.
. The secondary hues.
. Examples of the basic hues in everyday surroundings.

**PRESENT MEDIA.**

**SUGGESTED FOLLOW-UP ACTIVITIES:**

Student performance of color-mixing demonstrations seen in the film would reinforce learnings, and might also stimulate greater appreciation.

If some of the basic pigments are available among the art supplies, students might perform such experiments as:

. Using primaries to mix secondaries.
. Using primaries and secondaries to mix tertiaries.
. Changing values.
. Changing intensities.
. Painting natural examples with the hues produced.

## SUGGESTED RELATED ACTIVITIES:

To further demonstrate the chemistry of pigments and the effects of varying pigments, use the National Gallery slides and booklet, "Techniques of Painting."

To demonstrate how painters use color to express feelings in their paintings:

1. Show the portrait paintings in the CUE Science Kit Booklets, "Artist Jr.," as examples of warm and cool colors, using the opaque projector.

2. Show the following paintings from the same booklets:

   - Gaughin's "Siesta" as an example of color contrast; discuss the gay effect of strong bright color contrast.
   - Watkin's "The Sideboard" as an example of gentle gradations of color. Note that warm bright colors tend to make us feel happy, dark cool colors tend to make us feel sad and moody.
   - Picasso's "Le Gourmet" as an example of monochromatic color. (Monochromatic means different tints of the same color.)
   - Monet's "Poplars" as an example of the prismatic color painted by the impressionists. These artists were trying to capture the effect of sparkling sunlight on nature.

3. Encourage students to find such types of color use in the National Gallery of Art reproductions which are hung about the school. Ask them to talk about how the colors of each painting create a mood or feeling.

## RELATED CREATIVE ACTIVITIES:

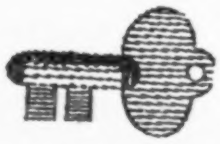
Students might undertake Science Fair projects involving color, such as:

- How we see color - an experience of the retina.
- Psychological effects of color as used in industry and medicine.
- Pigments and glazes.
- Paintings by talented students using hue variations for mood and expression.

## RELATED MATERIALS:

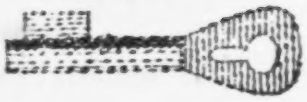
Films: "Color Magic" - Modern Talking Picture
"Color Keying in Art and Living" - Encyclopedia Britannica Films.
"Color - Lecture 12. Harvey White" - Encyclopedia Britannica Films
"Autumn Color" - Thorne Films

"Color Illusions" - Benham's disc, color wheels, color illusions. (CUE Science Kit)
National Gallery reproductions and booklets. (CUE)
National Gallery slides and booklet - "Techniques of Painting." (CUE)
CUE booklets on paintings.
Metropolitan Seminars of Art. (CUE)



CULTURAL ITEM: "COLOR-LECTURE 12. HARVEY WHITE" (Film)
30 min., Color, Encyclopedia Britannica Films.

CURRICULUM AREA: Light (color) - **The Properties of Light; the Spectrum. How we perceive color and color illusions.**



PURPOSES:

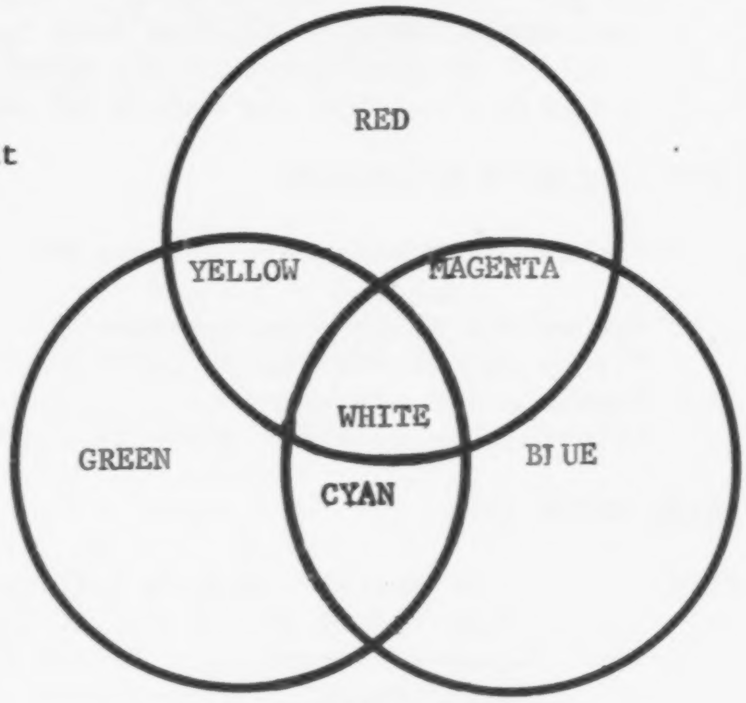
To contrast the results of mixing colored lights and pigments.

To point out the uses of color mixing techniques by photographers and stage technicians.

To acquaint the student with the physics of color.

SYNOPSIS:

Harvey White graphically introduces us to the spectrum. The light primary colors (blue, red, and green) are represented as the three points of a color triangle. A projector is employed to add the primaries to create the secondaries: magenta, yellow, cyan. Subtracting colors from the projector is likened to the subtractive process of mixing pigments, an artist's standard technique. The color triangle now is more elaborate; complementary colors are explained with reference to the triangle:

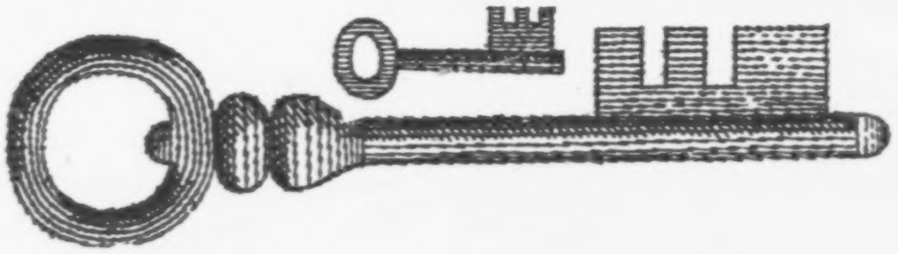


LIGHT PRIMARIES AND SECONDARIES

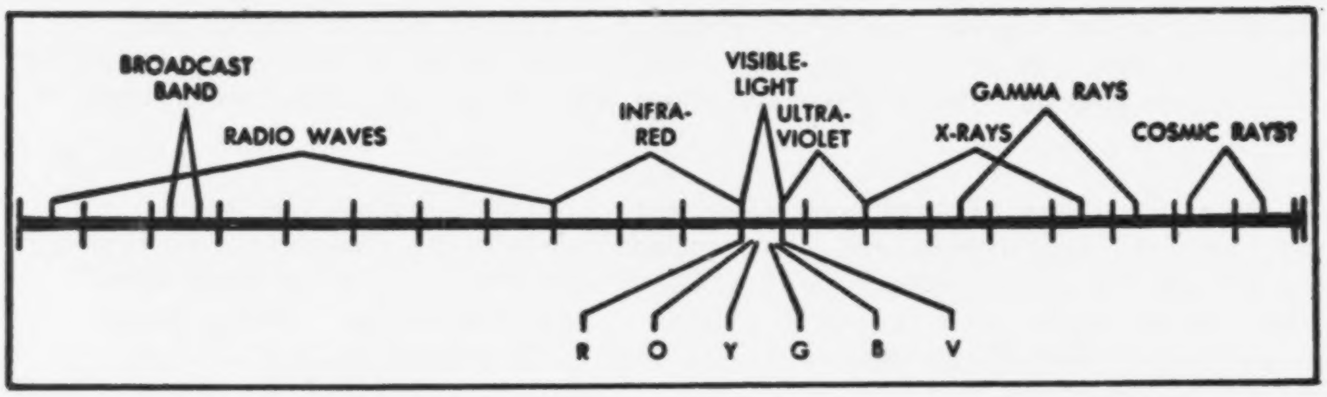
The Young-Helmholtz theory of color deficiency and color blindness is clearly described. Frequent recapitulations and repetitions of essential information tend to clarify the complicated subject matter content.

SUGGESTED PREPARATION OF THE CLASS:

1. In order to give the class a background for the film explain: All color begins with light. Without light there is no color. Light is radiant energy which travels through space in waves of different lengths. It is part of the electromagnetic field of radiant energy which has at the one end radio waves which are miles long and at the other end radium and cosmic rays whose length is an infinitesmal fraction so small that it is measured in millimicrons. (one billionth of a meter)



(Project or draw this chart on the board)



Within this field visible light rays which are also short, represent only 1/660 of the total radiation. Each wave length of light produces a color of the spectrum. Red at one end of the spectrum has the lowest frequency and the longest wave length (740 millimicrons). Red is followed by orange, yellow and green, blue and violet at the far end of the visible light band. Violet has the highest frequency and shortest wave length (380 millimicrons). In spite of the differences of wave length all light rays travel through space at the same role - an incredible speed of 186,000 miles per second.

Light rays can be reflected, refracted, absorbed and polarized. The reflection of light is most readily seen in a mirror or glossy surface. However, all colors are seen through reflection. A colored surface absorbs certain wave lengths of light and reflects light of all other wave lengths. Thus, red is perceived when a surface absorbs or subtracts all the colors except red. The red is filtered out of the white light and reflected to the eye. White is perceived when a surface reflects all colors, absorbing none.

2. Demonstrate how light can be broken in the spectrum with a prism and explain: The principle of refraction was first discovered by Sir Isaac Newton in 1666. He demonstrated that white light, when passed through a prism, is bent and broken into its various wave lengths, thus producing the colors of the spectrum. He also combined the spectrum into white light by means of a lens. Light is refracted whenever it passes obliquely through a transparent material such as a glass of water. Color effects, such as those seen in the facets of a diamond or in the rainbow, are caused by refraction. A similar result is accomplished by diffraction, when light falls across a grating or a surface of minute interstices.

3. To provide the students with an understanding of the differences between color addition and color subtraction, the teacher might demonstrate both. Three projectors fitted with cellophane color filters can be employed to show additive results at areas of convergence on the screen. The subtractive process might be illustrated by the removal of filters.

The three primary colors of light are red, blue and green. When added together they produce white light. Any two of these primaries added together will produce the complement of the third. Thus red plus green makes yellow, the complement of blue; blue and red make a red-blue or magenta, the complement of green; green and blue produce a blue-green or cyan, the complement of red. A primary and its complement, when of the same intensity, will also make white. These physical laws are all examples of additive color.

One can mix colors of light equally well by the subtractive method. In fact, this is the oldest and most common process of chromatic mixture. It is achieved by using transparent filters which select or absorb some wave lengths of light and transmit others. To illustrate: white light passed through a red filter gives a red light, because the red filter absorbs blue and green and transmits red. The complementaries of the three primaries subtract to yield black.

4. The eye sees color by means of rays of light reflected from objects. Light falls on the retina and is transmitted to the brain by means of photo-receptors, minute cells know as rods and cones located in the retina. Rods transmit white, grey and black and function even in low illumination. Cones transmit color and function for direct vision. Young and Helmholtz developed a theory of how we see color. This theory states that the eye has three kinds of color sensitivities which respond to red, green, and violet light. This film will explain this theory:

PUPILS SHOULD LOOK AND LISTEN FOR:

- The additive primaries and secondaries.
- The subtractive chart.
- The Young-Helmholtz theory of color perception.
- The cause of color blindness or deficiency in color perception.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

To insure understanding ask:

- Why is light needed before we can see colors?
- How do complementary colors in light differ from complementary colors in paints?
- What are the primary colors of paint? of light?
- Discuss dichromatic and achromatic vision and the Hardy-Rand-Ruther and Ishikara tests for color blindness (see 1964 World Book, Volume 4).

To illustrate color vision, perform the following experiments:

1. To prove that color is experienced by the cones which are located toward the center of the eye hold a piece of colored paper at arms' length to the side. Gradually move the paper to the front of the eye. The paper will not appear colored until it is perceived by the cones.

2. Secure and display the World Book 1964. Stare at the green, black, and yellow American flag (Volume 4, p. 662) for 30 seconds then look at a white paper to see the after image in proper colors. The after image is caused by the fatigue of the retina.

3. Look at the color illusions chart (p. 662) to find that the same color looks different on two different colored background. Scientists believe that we see differences in color better when we see them together than separately.

4. View a red and a green object in the dark (they will appear grey) under red light the red will appear normal, green will look black; under blue light both will look black; under green light the green object will appear normal and red will look black.

5. View high intensity red on a background of high intensity blue green. The colors will appear to vibrate because the eye cannot focus on red and blue green at the same time.

6. Explain to the students Impressionist painters were interested in optics and light experiments of the scientists in the 19th Century. They hoped to produce the effect of light by breaking up their colors in little dots and dabs which blended together in the eye to give the impression of shimmering sunlight. View Impressionist paintings by Monet, Manet, Renoir, Suerat, Signac from Metropolitan Seminars or National Gallery prints.

SUGGESTED RELATED ACTIVITIES:

Use the World Book to show and explain the Munsell and Oswald color systems.

SUGGESTED RELATED CREATIVE ACTIVITIES:

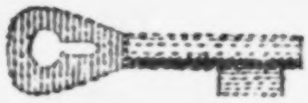
Some students may make a color projector to demonstrate the additive and subtractive color light charts with color filters. (Instructions will be found on page 660-661, Volume 4, 1964 edition World Book)

Have students use a Polaroid camera to photograph plastic objects and crushed cellophane.

**Light is also broken up into colors by polarization. Certain substances such as quzrtz, sugar or clear folded cellophane, have been found to possess the power of forcing a light ray which would ordinarily travel in one direction but would vibrate in many different planes, to vibrate in one plane only. This process is known as polarizing and the principle is used in the making of sun glasses and certain camera lenses. If the polarizing substance is placed between two prisms and then rotated, the rotation will separate white light into a temporary sequence of monochromatic bands.**

RELATED MATERIALS:
Film:
Discovering Color. (Film Associates of California)

CULTURAL ITEM: **"TECHNIQUES OF PAINTING"**
**(40 slides and lecture booklet by National Gallery)**
CURRICULUM AREA: Light, Color and Chemistry- **Properties of Pigments**
Techniques of Painting



PURPOSES:

To acquaint students with pigments and binders used in painting.

To alert students to the origin and chemistry of pigments, and to establish an awareness of them in the various techniques of painting.

SYNOPSIS:

This lecture and accompanying slides will illustrate the five most often used techniques in painting, the pigments and the binders which hold the pigments to the base, and will give examples of how these materials look in painting.

SUGGESTED PREPARATION OF THE CLASS:

To prepare students for viewing the slides, explain:

A pigment is a powdery, colored substance which does not dissolve in a vehicle such as oil or water, but remains suspended. Many pigments are made from earths and minerals, others are chemical compounds.

Artists and scientists who work with colors must understand the chemistry of color, because some pigments and vehicles are incompatible. Improper combinations can cause paints to crack, darken, fade, blister or fail to dry. This knowledge is of utmost importance. Slides will help us learn something about these pigments.

PUPILS SHOULD LOOK AND LISTEN FOR:

- Earth colors; mineral, animal and vegetable pigments.
- Colors manufactured by chemical processes.
- Various kinds of binders.
- Egg tempera, fresco and oil painting.
- Gesso and glaze and other techniques.
- Origin of pigments; varieties of techniques.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

1. If possible, secure a set of oil paints and squeeze some on a palette. Have samples of tempera, water color, casein paint, pastel, colored chalk, plastic paint, turpentine, oil, varnish. Allow students to inspect the media. Help them identify such colors as earth tones, ultramarine, umber, ochres, alizarin, Madder, zinc white, viridian.

2. Allow them to experiment briefly with these media. Help them to understand:

   - The "earth" palette. Name some painters who used it.
   - The "Impressionist" palette and what aspects of science made it possible.
   - The chemical reaction involved in fresco painting, and why speed is necessary in this process.
   - The advantages of the oil technique. (It is slow-drying, thus can be worked over for a long period. It is versatile. It can be thick and opaque or a transparent glaze.)
   - The advantages of egg tempera. (Colors remain bright.)

3. Assist students to understand that media and tools, as well as the artist's concept and techniques combine to produce various effects in painting. He must know something of the chemistry of pigments to have his works last in good condition. Show prints of paintings by Ryder to illustrate the point.

4. Have students look at the National Gallery Reproductions and other prints to judge the media and techniques used.

SUGGESTED RELATED ACTIVITIES:

Explain: Knowledge of pigments is vital to chemists in industry. Much research is done on color, handling qualities , opacity or transparency, tinting, strength and toxic qualities of pigments. Great stretches of boards are painted and left to wind, rain and sun to determine the most durable paints for homes, automobiles and machinery.

Colorimetry is a new area of study related to electromagnetism, the measuring of light waves and chemical analysis by means of color. This scientific aspect is also applied in color TV, color photography and fine printing.

Another interesting area of exploration is the color chemistry found in the plant world. Color in flowers, fruits and leaves is due to the presence of water **soluble** substances in sap or plant sugar.

SUGGESTED RELATED CREATIVE ACTIVITIES:

Students especially interested in color may be assigned to research or experiment with, possibly for a science fair exhibit:

- Plant coloration.
- The spectroscope.
- The history of pigments and binders, their sources and when they were first used.
- Psychological aspects of color.
- Animal coloration.
- Light polarization. (Make photographs of crushed cellophane and other plastic objects.)

CULTURAL ITEM: "AUTUMN COLOR" (Film)
7 min., Color, Thorne Films

CURRICULUM AREA: Color - **Learning to Look - Becoming more sensitive to color in nature.**
Biology
Botany

PURPOSES:

To awaken an awareness of the artistic qualities inherent in nature.

SYNOPSIS:

"Autumn Color" is an audio-visual "experience" film; the camera is accompanied only by a subtle piano improvisation (no narration), as scenes of autumn foliage are grouped by colors and subtle hues against varied backgrounds and with a variety of lighting.

SUGGESTED PREPARATION OF THE CLASS:

1. The students should be prepared for the absence of narration in this "experience" film. The reasons for such absence could be discussed so the class will appreciate that fact that the theme of the film is related by the arrangement of the artistic photography and the accompanying piano.

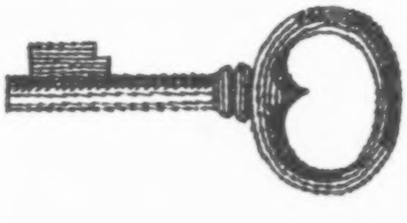
2. As a means of making the film more informative, you might provide your class with the following guide to film scenes:

. Yellow of cottonwood against a mountain background.
. Locust tree and milkweed.
. The orange and red of plum, sumac and hawthorne.
. Subtle hues and shadows formed by backlighted Virginia creeper leaves.
. Gold of cottonwood against the dark shadow of a canyon.
. The flickering effects of quaking aspen in the wind.
. The contrasting yellow and orange of sugar maple followed by the brilliant red of sumac and **bayberry.**
. The variety of color, light and textures exemplified by oak leaves.
. **In** the final scenes, sugar maple against a mountain background.

PUPILS SHOULD LOOK AND LISTEN FOR:

. How music seems to establish moods that conform with color scenes.
. Art forms in nature.
. Color contrasts in nature.
. Beauty in simplicity.
. Effect of lighting on photographic subjects.
. Scenes listed in the guide presented in SUGGESTED PREPARATION OF THE CLASS.

PRESENT MEDIA.



## SUGGESTED FOLLOW-UP ACTIVITIES:

Students should realize that many of the scenes they have witnessed are beauty in the everyday environment that most of us tend to overlook. An analysis by the class of the film's photography could elicit the fact that:

- Photography enables us to capture scenes that we can view repeatedly for our esthetic enjoyment.
- Photography helps us see beauty, pattern, form and texture, so that we are more perceptive of these elements in our environment.
- Framing excludes extraneous material, and helps us to concentrate on a specific section, resulting in more thorough perception.

## SUGGESTED RELATED CREATIVE ACTIVITIES:

- An exhibition of student photographs of natural scenes with interesting design, texture and color could be motivated by the utilization of this film.
- Students may bring in and display "found" objects such as driftwood, stones, bark, metal objects or others which are interesting in shape, texture and color which we ordinarily do not notice in our environment.

## SUGGESTED RELATED ACTIVITIES:

- Student research into the biological reasons for autumn colors, including the nature of deciduous plants and the pigments accompanying the various chlorophylls in different plant species.

- Similar research into the physical topic of the wave lengths of light which are absorbed and reflected by the leaves of different plants.

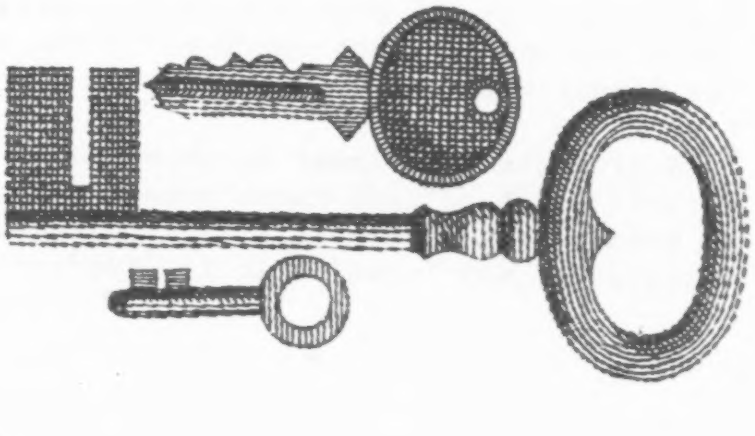
## RELATED MATERIALS:

### Filmstrips:

The Simple Camera. (Kodak)

### Film:

Nature's Half Acre. (Walt Disney Films)



**CULTURAL ITEM:** "THE FLAMING SKY" (Film)
29 min., Color, McGraw-Hill Text Films

**CURRICULUM AREA:** Science - Light (spectrum), Communication;
Earth Science - Atmosphere, The Sun
Observing earth phenomena more meaningfully.

**PURPOSES:**

To explain in detail, theories and findings regarding the auroras.

To make students aware of the need for international cooperation in investigation of earth phenomena.

**SYNOPSIS:**

Extraordinary high-speed motion photography of the auroras of the high northern latitudes (Aurora Borealis), "The Northern Lights" provides the motivation for the film.

Some old theories are reviewed. We learn that two thousand years ago, Roman legions marched to "put out the fires in the distance," that the lights were once thought to be reflections from the Norwegian ice fields, that Benjamin Franklin correctly hypothesized that the auroras were electrical in nature.

World-wide observations of associated phenomena are noted such as magnetic field and radio disturbances. Data-gathering methods are displayed and explained. The height is determined by triangulation, for example, using cameras and the relative positions with respect to fixed stars. Visual observers report the incidences and forms of displays to computer centers. We see special cameras in operation which can view the entire sky at once. Scanning photometers measure auroral brightness which is from ten to one thousand times the usual brightness of night. Radar is employed, sometimes air-borne, to report "unseen" shows.

The association of auroras, solar flares and sunspots is pointed out. Artificial auroras are shown produced in partial vacuum tubes when electricity is fed into them. The colors are believed to be produced by the emission of light caused by bombardment. A spectrograph compares these colors with those of actual displays. Rockets which are fired into auroras corroborate this by reporting excessive electrons as the major correlative of the lights. A map is made of the data and a tentative conclusion is reached that the auroras are caused by electrical particles coming from outer space, (the sun), that their bombardment of our high atmosphere causes the emission of light, and that the particles involved are confined by the earth's magnetic field and diverted to the magnetic poles.

A dramatic experiment is shown which proves the truth of the hypotheses. Rockets which release known quantities of atoms are fired from shipboard, and an atmospheric aurora is artificially produced. An animated diagram demonstrates the way in which it is diverted to the magnetic poles.

## SUGGESTED PREPARATION OF THE CLASS:

To orient students and insure a background of knowledge:

1. Try to get a first-hand account of an aurora, if possible, by asking any students who might have seen the Northern Lights to describe them.

2. Indicate the scientific name of the Northern Lights, Aurora Borealis, and the Southern Lights, Aurora Australis. Ask why they are not seen during daylight even though they are present.

3. To promote comprehension of the main topics in this fast-moving, fact-filled film, explain to the students that they will be seeing:

- Data-gathering devices, some world-wide.
- Various theories, some based on and corroborating the data.
- A rocket experiment designed to test the theory that auroras occur when radiation from the sun is diverted toward the magnetic poles of the earth, and producing light when it strikes the upper atmosphere.

## PUPILS SHOULD LOOK AND LISTEN FOR:

- The different instruments scientists use to expand our perception of this phenomenon and how they are used.
- The influence of the Earth's magnetic field on solar radiation.
- The analysis of auroral light by means of a spectrograph.
- Recent developments in rocketry.
- Recent developments in photography.
- Why radiation causes atoms in the atmosphere to emit light.

## PRESENT MEDIA.

## SUGGESTED FOLLOW-UP ACTIVITIES:

The following activities may reinforce learnings from the film:

- To point out the importance of small-scale experiments as models of natural phenomena, the teacher may set up a Crooke's, neon or fluorescent tube and introduce electrons into it with an induction coil, making a miniature aurora.
- By asking students to tell which aspects of the investigation of the cause of auroras would have been hampered or even halted by lack of cooperation among nations, the teacher can emphasize the necessity of world-wide participation in exploring the characteristics and secrets of the planet we all live on.

## SUGGESTED RELATED ACTIVITIES:

To promote further understandings related to solar activity and its study:

- Explain that Aurora was the name of the goddess of dawn in Roman mythology.
- Discuss why long-range communications are disrupted during solar activity such as sunspots and flares. Ask why auroras are also especially evident during these periods.

- Point out the need for high-speed photography in capturing the beauty of the fast-changing aurora. Ask what other observations are best made through high-speed photography (e.g., insect and bird flight).

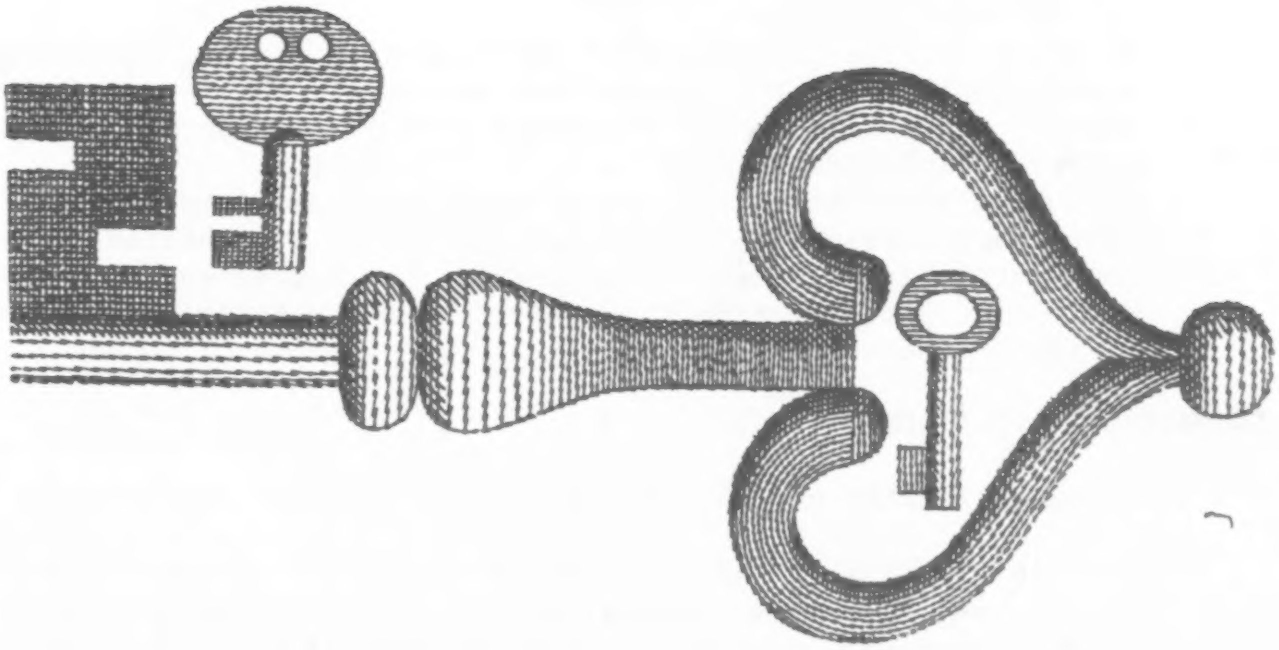
**RELATED MATERIALS:**

**Film:**

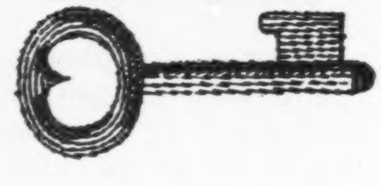
"Our Mr. Sun" - Parts I and II
29 min. each, Color, Bell Telephone

**Recording:**

"Why Does the Sun Shine?"
Space Songs Science Materials Center
59 Fourth Avenue
New York City



CULTURAL ITEMS: "COLOR DISCS - BENHAM'S DISC" (CUE Kit)
"WORLD BOOK COLOR, ILLUSIONS"
"LIGHT AND GELATIN FILTERS"



CURRICULUM AREA: Light and Color
Background for understanding Color.

SYNOPSIS AND RATIONALE:

While it is possible to enjoy color without understanding the theories behind it, they open up interesting avenues for thought and experimentation when these theories are explored.

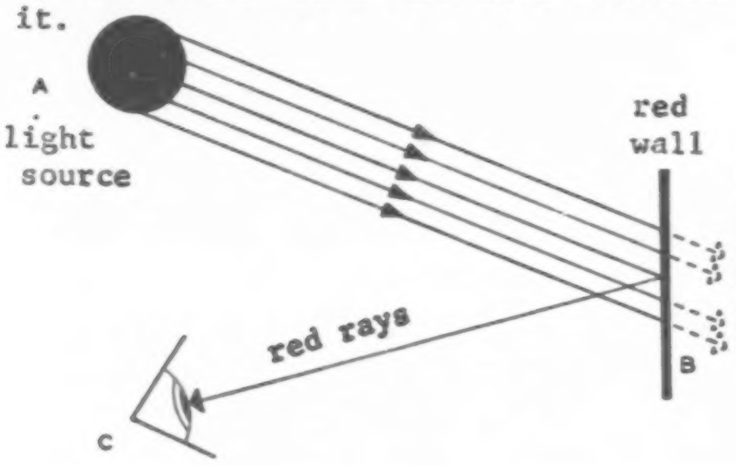
Knowledge of color theories and experiments performed with color and Benham's discs and color illusions provide opportunity for assisting students to become more perceptive to color.

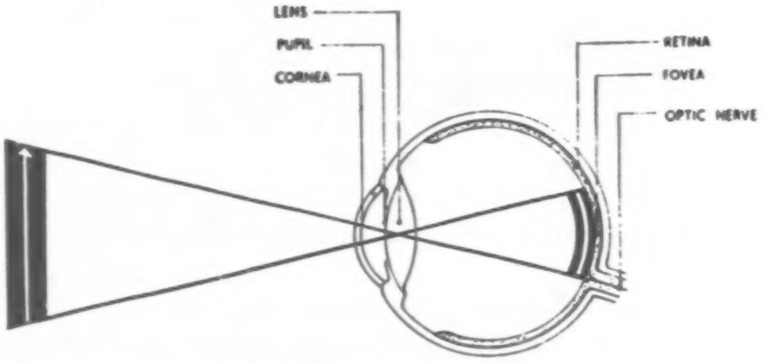
SUGGESTED PROCEDURE:

Explain to the class: Color is an important aspect of modern life. It not only beautifies clothing, looks, homes, public buildings, advertising and packaging but also has a great effect on human life. Yet many people go through life unaware of its beauty.

Color surrounds us. We cannot escape it but whether we enjoy it or not depends on our ability to see. Understanding color illusions and theories helps us observe and enjoy beautiful colors.

Color is a property of light. When light falls on an object, the object absorbs some of the light rays and reflects others. The light rays absorbed by the surface of a wall will determine the sensation of color we receive from it.





LIGHT RAYS REFLECTED FROM THE SURFACES OF A BUILDING PASS THROUGH CORNEA PUPIL AND LENS TO A FOCUS ON THE RETINA. THE IMAGE IS UPSIDE DOWN AND REVERSED LEFT TO RIGHT. THE FOVEA IS THE AREA OF CLEAREST VISION

A red object absorbs all rays except red ones which it reflects. The reflected rays travel in a straight line, enter the lens of our eye and are focused on the retina at the rear of the eye. Pigments and dyes have color because they reflect or transmit only certain colors and absorb others. Color may also be produced by the splitting apart of light. The blue of the sky is produced by moisture in the air which scatters the blue rays of sunlight more than it does the red rays. Films of liquid, such as oil on the water of soap bubbles produce color. Colors on insects or birds' wings result not from pigment but from the way in which light is split apart.

Newton's Theory 1666 (Demonstrate with prism)

Newton proposed the first well organized color theory. He found that white light when passed through a prism could be bent to produce a spectrum. He said each of the seven basic colors had a specific wave length and that all lights of a specific color when passed through a prism would be bent to a degree that was characteristic of that color. This theory has been the main color theory used.

Young Helmholtz Theory (circa 1807)

This theory stipulates that the eye contains three types of receptors or nerve endings - sensitive to each of the primary colors which are (slightly different in light than in pigment) magenta, cyan (blue green) and blue-violet. In this system colors are "additive" by adding them other colors are formed.

Magenta plus blue violet equals red.
Magenta plus cyan equals yellow.
Cyan plus blue violet equals blue.
Cyan plus blue violet plus magenta equals white.

These primaries are used in stage lighting, decorating, photography and other art forms where colored lights are involved. Impressionists painters tried to employ the light primaries in their painting. Pointillists hoped their dots of color would fuse in the eye. Since they were working with pigments and not light, these experiments were not so successful. (Show paintings by Seurat, Signac, Van Gogh. Spin color discs to demonstrate how color mixing goes on in the eye.)

Pigment Primaries (Subtractive primaries)

Red, yellow and blue are pigment primaries - by mixing we get secondaries.

Red and yellow equal orange.
Yellow and blue equal green.
Blue and red equal violet.

When we mix two of the primaries they subtract or neutralize their complements and reflect their remaining components.

As an example, when yellow and red are mixed, the results are as follows: the yellow consists of a reflection of wave lengths of vermillion and emerald. The red contains vermillion and blue-violet. The blue-violet rays in the red are subtracted by the yellow, and the emerald rays in the yellow are subtracted or neutralized by the red. Vermillion or orange rays would remain. The neutral or gray that is introduced in this process reduces the brilliance of the mixture. For this reason, the most valuable primaries are those that have the highest average value. The triad red, yellow and blue was chosen because, at the time, due to the poor quality of colors, these were the brightest. Today the brilliance of new paints encourages us to try other triads such as the ones used by printers - magenta, turquoise and yellow.

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Two other pigmentary color systems worthy of mention are the Munsell and Oswald theories. Both of these are three-dimensional measurements of color and have been very valuable in standardizing color for industrial purposes. Oswald's system is based on four primary colors and Munsell uses five.

Up until 1959 all color theories had been based on the 300-year-old findings of Isaac Newton. In 1959, Edwin Land of Polaroid Corporation made a discovery, while working with colored photographs, that may revolutionize all color theory. All colored photography and colored television in the past has been based on a process that was introduced by James Maxwell. Maxwell used the "additive" primaries, vermillion, emerald, and blue-violet. He exposed three individual black and white plates through filters of these three colors. These black and white negatives were converted to transparent positives. When the three positives were projected individually through their original filters, they produced a composite image in lifelike color. Land found that a colored picture could be produced by using only two negatives. The first negative is exposed through a red filter and is called the "long record" because it records the long-wave lengths. The second negative is exposed through a green filter and is called the "short record" since it records the shorter wave lengths. The two negatives are then converted to positive black and white transparencies. If the "long record" is projected through a red filter and the "short record" is projected only with a white light, and if the two projections are registered, a picture of the original subject will appear in full color.

After making this discovery, Land found that others had had experiences similar to this but that they had explained these red and white projections as some sort of eye fatigue. Land carried his experiments still further in order to prove that the white light was not in some mysterious way supplying the other colors of the spectrum. He found that in some regions of the spectrum he could use any two colors if they were at least ten millimicrons apart, and if the longer of the wave lengths were used to illuminate the "long record."

In the blue region of the spectrum, however, the process reverses and the color is correctly reproduced only if the shorter wave lengths are used to illuminate the "long record" and the longer wave lengths are used for the "short record." In this case, a full color picture can be produced from two black and white transparencies that are illuminated by two different blue lights. These findings are so new that they have not yet been fully investigated. It is believed, however, that they will be immediately put into practice in the field of television. Time will tell how the artist will be affected by these new findings.

One may study color from anyone of four scientific approaches.

1. The physiologist studies color from the way it is received by the eye. They do studies to determine how factory employees can produce more work with greater ease by means of color conditioning their surroundings to reduce eye strain and fatigue.

   Warm colors (red, orange, yellow) tend to be exciting, for they increase blood pressure and pulse rate. Cool colors (blue, green, violet) are quieting in that they reduce blood pressure and pulse rate. Recently scientists have developed a new science called functional color. They find that color has a great influence on our comfort and efficiency and emotional well-being. By controlling light with color, we can increase production and comfort among workers; for color affects us both physically and emotionally.

Research has been done to find the most pleasing and comfortable colors for various aspects of life.

Blue-green tile and glass are often used in operating rooms because it relieves glare and lessens contrast and is therefore easier on the eye.

Warm colors (pink, peach, and ivory) cheer patients and help them want to get well.

2. The psychologist studies the emotional effect of color on persons.

   Color control is used in school rooms and factories to produce physical comfort and the proper emotional tone. Color is used for safety also. Each color now has a special safety meaning. (See "Color" in World Book for more on this topic.) Color can also be used to reflect heat.

   Many individuals have color likes and dislikes and are affected emotionally by those hues in their surroundings.

   Tests show workers feel that some colors are heavier than others and show more fatigue in carrying cases of colors than others even though the cases are of identical weight.

3. The physicist studies wave lengths and intensities of light. Their experiments illustrate the fact that colored lights when mixed do not produce the same results as would be secured by mixing pigments of the same hues. (see CUE lesson on Color Harvey White Lecture 12).

   Light mixing of this type is used by television and stage technicians, and photographers to secure artistic effects. The lighting engineer for dramatic productions can create color effects with lights that would take a painter hours of labor and gallons of paint to achieve. Whole backgrounds can be changed by the use of different lights. Certain chemicals such as zinc, phosphorous and radium bromide can also change color effects when various lights are reflected on them.

   Lights may be mixed to form any number of brilliant colors as well as white.

4. The chemist studies the chemical properties of the natural and artificial coloring materials used for the manufacture of dyes and paints. He knows pigments mix differently and produce different hues from mixtures of colored light. His job is to find formulas of paint colors that will spread easily, test problems of cracking, peeling, washing, fading. He also seeks sources of new pigments and dyes. (See CUE lesson "Discovering Color.")

SUGGESTED FOLLOW-UP ACTIVITIES:

1. Show the National Gallery slides - Techniques of Painting - to learn more about pigments.

2. Show the CUE film "Discovering Color" to learn more about mixing pigments.

3. Show the CUE film "Color - Light" to learn about mixing light.

4. Have students make a colored light projector (see World Book "Color") to experiment with mixing light.

5. Spin color discs in CUE Kit to observe color mixing in the eye.

6. Spin Benham's disc to observe color illusions. See other color illusions in "World Book" "Color."

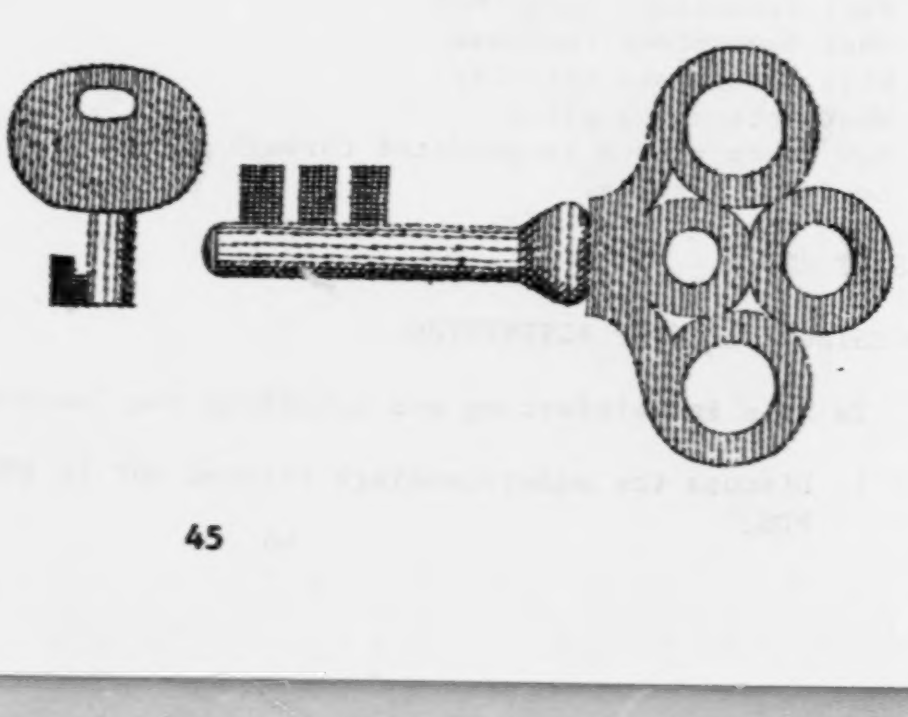
7. Take photographs of the same group of objects in different colored lights to observe the changes in color.

8. Have students perform this experiment:

   Put a dab of wax on a piece of white cardboard, another on a black piece of cardboard. Now hold both pieces over an electric light bulb. (The black melts first, proving that black absorbs heat; white reflects it.)

   Ask, "Does this knowledge about color influence people's choice of color in clothing?"

9. Do research on the psychology or chemistry of color or the spectroscope as "Science Fair" projects.



**CULTURAL ITEM:** "SOUND WAVES AND THEIR SOURCES" (Film)
Encyclopedia Britannica Films - 1150 Wilmette Ave., Wilmette, Ill.
11 minutes, black and white.

**CURRICULUM AREA:** Science - Sound
Learning to Listen - How Sound is Produced.

**PURPOSES:**

To explain and demonstrate the production and characteristics of sound.

**SYNOPSIS:**

A brief orchestral performance opens the film. A slow motion tuning fork diagram shows how sound is produced. Frequency, the nature of sound waves, amplitude and pitch are explained, followed by a short revisit to the orchestra where the aspects of quality are introduced. The concepts of fundamentals and overtones are examined with the aid of an oscilloscope which operates during a violin performance; the organ pipe and man's vocal mechanism are then considered.

**SUGGESTED PREPARATION OF THE CLASS:**

To help students develop a concept of what sound is, explain that sound is produced by vibrations which cannot be seen. When the prongs of a tuning fork vibrate, they set up invisible waves in the surrounding air. However, when a tuning fork is struck and then placed in a dish of water immediately, the effect of these vibrations can be seen easily.

Before meeting with the class, you might place the following terms on the chalkboard to aid in a discussion and explanation of the understandings involved:

frequency
condensation
rarefaction
oscilloscope
partial
velocity
amplitude
pitch
vibration
compound tones

**STUDENTS SHOULD LOOK AND LISTEN FOR:**

. How sound waves are produced.
. What determines frequency.
. What determines loudness.
. What determines velocity.
. What determines pitch.
. How human speech is produced through a vibrating column of air in mouth, head and trachea.

**PRESENT MEDIA.**

**SUGGESTED FOLLOW-UP ACTIVITIES:**

To help in reinforcing and extending the learnings of the film:

1. Discuss the understandings pointed out in STUDENTS SHOULD LOOK AND LISTEN FOR.

2. Discuss how sound is produced in:

   - Stringed instruments.
   - Drums.
   - Brass instruments.

3. Have pupils construct a cardboard instrument of a box or boxes and rubber bands.

4. By plucking, have students demonstrate:

   - Fundamental tone (longest wave length).
   - A second partial (half of fundamental tone).
   - A third partial (half of a second partial).

5. Fill test tubes in a rack with varying amounts of water. Have pupils blow to produce varying tones and then tunes.

6. Some pupils may wish to construct musical instruments from boxes, plywood, tin cans or other usable materials that lend themselves to this purpose.

7. Ask the music teacher to follow up with a demonstration of how sound is produced on various musical instruments.

RELATED MATERIALS:

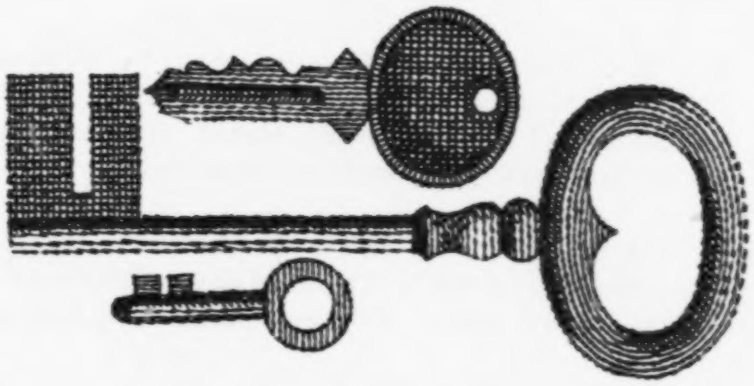
Films:

"Listening to Good Music" - Encyclopedia Britannica Films
14 minutes, black and white.

"Playing Good Music" - Encyclopedia Britannica Films
15 minutes, black and white.

Recording:

Science of Sound - Bell Telephone (33 1/3 RPM)



CULTURAL ITEM: "THE SCIENCE OF SOUND" (Recording)
Bell Telephone Company

CURRICULUM AREA: **Sound - Learning to Listen.**
**Increasing Discrimination of Sound.**

PURPOSES:

To aid the listener to understand how sound is put to work for the benefit and pleasure of man.

SYNOPSIS:

This recording illustrates the points it makes through clear narration and a variety of audio aids largely unattainable or impracticable in the ordinary classroom demonstration. There are ten bands on the two sides of the record, which is accompanied by a booklet which provides the complete script:

1. "How We Hear" explains clearly how the vibrations of a drum reach the ear and then the brain, where they are interpreted as sound.

2. "Frequency:" The range of human hearing (20 to 20,000 cycles per second) is demonstrated by a sweep tone.

3. "Pitch:" A violin, singer and vibrating cardboard emitting the same pitches of A440, and then A880, prove that we cannot depend on our ears to determine relative frequencies.

4. "Intensity:" The intensity of a sound is fluctuated by increasing and decreasing the power of a buzzer, and by moving a microphone toward and away from an oscillator. The decibel scale is portrayed by tones and voice.

5. "The Doppler Effect:" The changing pitch of the sound of a moving train whistle, bell and racing cars illustrate the Doppler effect; pitch increases as an object moves toward you and decreases as the object moves away

6. "Echo and Reverberation" are represented by voices echoing at various intervals and a re-creation of the acoustics of the Tower of Babel.

7. "Delay Distortions" may occur in communication lines because frequencies may not travel with equal velocities. We hear the effects of such delays on speech and on a trumpet fanfare.

8. "Fundamentals and Overtones:" Fundamentals are the lowest frequencies in a complex sound; overtones are those frequencies higher than the fundamental tone. Pure tones and plucked strings are employed to illustrate both fundamentals and overtones.

9. "Quality:" A factory whistle, piano and human voice at the same pitch and intensity vary in quality. Through filtration of these sounds, we learn that the differences in quality are determined mostly by overtones.

10. "Filtered Music and Speech:" High and low frequencies are filtered from an orchestral performance and human voice.

Note: "Filtered Speech and Music" will be used to illustrate the suggested method of utilization of each of the other bands of the recording.

SUGGESTED PREPARATION OF THE CLASS:

. The appropriate portion of the accompanying booklet can be read for a brief preview for the establishment of a secondary purpose in this case. "To help students understand the nature of high-fidelity."
. Help students develop the concept of sound filtering by playing a recording on a new and then on an old-fashioned record player. As a alternative compare a modern high-fidelity recording and an older recording, using the same record player. Ask the class to try to describe the differences they perceive.

. You may want to further motivate the students to find out more about filtered music and speech by eliciting or relating the story of the expensive "acoustical clouds" in the New York Philharmonic Hall of Lincoln Center which were replaced because of their failure to reflect accurately the lower tones.

PUPILS SHOULD LOOK AND LISTEN FOR:

. Ways in which sound may be produced.
. Ways in which pitch is varied.
. What happens when your ears are prevented from vibrating throughout the normal range of frequencies.
. Differences in quality of sounds.
. Production of overtones.
. Grieg's "Weddingday at Troldhaugen" played with various filters and without filters.
. What speech sounds like when some of its frequencies are filtered.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

. The elicitation from the class of a definition of high-fidelity, based on information gained from the recording, could serve as a summary. High fidelity may be regarded as the reproduction of sound with the minimum of filtration.
. How high-fidelity is achieved might be demonstrated by a student or the teacher showing the "WOOFERS" and "TWEETERS," which are speakers especially constructed to transmit certain ranges of frequencies.

RELATED MATERIALS:

Films:

Listening to Good Music. (Encyclopedia Britannica Films)
Playing Good Music. (Encyclopedia Britannica)
Sense Perception. (Moody Institute of Science)
Sound Waves and their Sources. (Encyclopedia Britannica Films)

**CULTURAL ITEM:** "LISTENING TO GOOD MUSIC" (Film)
Encyclopedia Britannica Films
14 minutes, black and white.

**CURRICULUM AREA:** Science - Sound and Music - Learning to Listen
How musical instruments produce sound.

**PURPOSES:**

To familiarize students with the string quartet and its instruments.

To develop the concept of music as a means of communication.

**SYNOPSIS:**

The Fine Arts Quartet illustrates the nature of the most popular of instrumental quartets, the string quartet, by playing excerpts from a variety of pieces. The narrator describes music as a kind of language which, when better understood, is better appreciated. The composer sets down a "message" through notes which are brought to life by the interpretation of the players.

A closer look is taken of the instrumental members of the string quartet, (first and second violins, viola, cello), and the origin and age of those used in the film are discussed. The second violin is the youngest, having been made in 1772 by Balestrieri, who was influenced by Stradivarius, the master violin-maker, one of whose masterpieces is the first violin in the film (1729). The cello, more than two hundred years old, was made by Gofriller; the viola, more than four hundred years old, was made by Gasparo da Salo.

A schematic diagram points out the relationship of the four basic voices of a vocal group (soprano, alto, tenor and bass) to the six-octave range of the instruments.

We hear how the composer used tonal qualities (timbre) of the instruments to create moods. "Quartet in D Major, Opus 76, No. 5, Finale Movement," demonstrates Haydn in a gay mood, whereas his "Quartet is A Flat Major, Opus 20, No. 5, Adagio," suggests a lullaby. Mozart has a stately minuet in "Quartet in B Flat Major K.458" and Wolf a lively tarantella in the beginning of "Italian Serenade." Schubert is sad in his "Quartet in D Minor, Third Variation." We hear how a theme is introduced by the first violin, how the second violin and viola pick it up, and how the cello takes over.

The final part of the film is an unnarrated performace of the Finale Movement of Haydn's "Mama-Papa Quartet in C Major, Opus 33, No. 3."

**SUGGESTED PREPARATION OF THE CLASS:**

To orient student thinking and give a basic background for understanding:

1. One or more string quartet instruments (violin, viola, cello) could be demonstrated by talented students and examined both as musical communication devices and as producers of sounds of varying pitch, intensity and quality.

2. The concept of tonal range might be introduced by playing the entire range of frequencies on demonstration devices available in the school (glasses filled with varying amounts of water, sliding whistles, rotating discs, vibrating strings). The class can determine the upper and lower limits of each by comparison with known frequencies, such as those of marked tuning forks.

3. The importance of the production of sound quality and overtones as the essential variable involved in the value of an instrument may be emphasized by explaining how the instruments featured in this film are distinguished in age and maker. (See Synopsis.) The class may be surprised to learn that people will pay as much as $100,000 for a Stradivarius stringed instrument, of which fewer than four hundred exist today, although Stradivarius made about 1200 in the 18th Century.

PUPILS SHOULD LOOK AND LISTEN FOR:

- The relationship of composer to players.
- The age and origins of the instruments.
- How the larger instruments play the lower notes.
- The frequency ranges of each string quartet instrument.
- The relationship of the instruments to the basic four voices of a vocal group.
- How identical frequencies played on each instrument differ in quality.
- How different moods are expressed in music.
- Why the Finale Movement of Haydn's "Quartet in C Minor" is called the "Mama-Papa Quartet."

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

1. To further explain the physics of musical instruments:

   Students might wish better understanding of why the sounds of the different instruments of the quartet vary even though they may be playing identical notes. The recording, "The Science of Sound," (See "Related Materials") provides clear explanations in Band 8, "Fundamentals and Overtones," and Band 9, "Quality."

2. To sensitize student hearing of music:

   Demonstrate that music can create moods by selecting pieces or parts of pieces to play which have generally agreed upon "moods." Your choice of such works is large, so special requisitions are unnecessary. Your music department might provide suggestions and materials. To allow students to react without the hindrance of vocabulary and expression problems, provide choices of moods on the chalkboard for each musical selection, and pool the class on each.

3. Capitalize on awakened interest by playing any tapes or discs listed in "Related Materials." These are full-length recordings of the works which include the excerpts in the film.

(See Page 47 for Related Materials)

CULTURAL ITEM: "PLAYING GOOD MUSIC" (Film)
15 min., B&W, Encyclopedia Britannica Films

CURRICULUM AREA: Sound - How sound is produced in music.

PURPOSES:

To sensitize students to sound in music through demonstration of how instruments produce sounds, pitch, harmony, rhythmic patterns and recurring themes.

SYNOPSIS:

This film demonstrates the sounds of various instruments and the method of changing these sounds through ways of playing them. It illustrates pitch amplification, vibrato, harmony and provides examples of rhythmic patterns and recurring themes.

SUGGESTED PREPARATION OF THE CLASS:

To orient the class explain: We appreciate music to the extent that it conveys meaning to us or produces a response in us. Thus, the more we know about how music is produced, the better we are able to grasp the feeling or meaning which the composer intended.

PUPILS SHOULD LOOK AND LISTEN FOR:

- Richer sounds with many notes sounding simultaneously.
- Techniques in playing individual instruments.
- The method of changing pitch in stringed instruments.
- The finger action on the strings when vibration is used.
- A way of varying amplitude of sound.
- Vibrato in music.
- Varying rhythmic patterns.
- Theme moving from one instrument to another.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

1. In order to test for comprehension of the material presented in the film ask the class:
    - What technique is used by the musicians to change the pitch of the instruments?
    - How is vibrato produced?
    - What technique is used to increase amplitude? To decrease amplitude?
    - How does the composer emphasize a single idea? (The four voices play a single note in unison.)
    - What are some things a good musician must be cognizant of in order to perform his part well?
2. Have pupils involved in music to bring instruments to class and demonstrate some of the various techniques. (The greater the variety of instruments, the better.)

SUGGESTED RELATED ACTIVITIES:

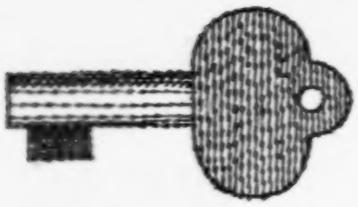
1. For further comprehension develop a discussion using the following questions as guides.

   - How is sound produced?
   - What is the frequency range of sounds we perceive?
   - What determines if a sound is musical or not?
   - What are some ways in which pitch is varied in musical instruments?
   - How is sound intensity varied?
   - How are overtones produced in musical instruments?
   - What enables you to distinguish between the sound of two different instruments even though they are producing the same pitch?

2. To help pupils understand better some of the characteristics of sound, the teacher might have them perform the following exercises:

   - To demonstrate changes in amplitude, clamp a meter stick on the edge of the table with three-fourths of the meter stick extending over the edge. First strike lightly and then harder and compare the loudness of the two sounds produced. Point out that the vibration rate does not change.
   - To demonstrate pitch use the meter stick in the same position on the table as before but without the clamp. Strike the end of the stick and note the pitch of the sound. Now move the rule in so that only about half of it extends over the edge of the table. Again, strike the end of the stick and note the change in pitch. Point out as less of the stick is caused to vibrate, its rate of vibration increases, and thus the pitch of the sound increases.
   - To demonstrate how overtones are produced, construct a monochord. Using a piece of board about 40 inches long, drive two nails into the board so that they are 36 inches apart. Bend the tops of the nails slightly toward each other and tie a piece of nylon fishing line near the heads of the nails. Now straighten the nails to increase tension in the line and lower the line until it is about one-half inch above the board. Place the meter stick lengthwise between the nails. Stand a small piece of meter stick, or comparable width block, on edge under the string at the nine-inch mark. Place little folds of paper at 13½-, 18-, 22½-, 27-, 31½-inch marks. Pluck the short section of the string and note that the paper folds at 13½-, 22½, 31½ inches fall off, showing that the string is vibrating in four equal sections. Point out that different instruments tend to emphasize certain overtones and even leave some of them out. It is this difference in overtone series and the relative strength of them that gives each instrument its tone quality.
   - Use eight thin glasses that produce a musical sound when struck. Line them up and fill each one with a different amount of water. By properly adjusting the water level in each, they can play a musical scale.
   - Use four small soda bottles to play "Taps." Leave bottle one empty. Put about 2 inches of water in bottle two, 3 inches of water in bottle three, and fill the last bottle to the halfway mark. Blow across each one in order to see if you get the note of "Taps." If a note appears too high, decrease the level of water; if too low, add some water. See if you can play "Taps" with these. For example; the first part, play bottles 1-1-2, 1-2-3, 1-2-3, 1-2-3, 1-2-3 ......

**CULTURAL ITEM:** "A WORLD IS BORN" (Film)
20 min., Color, Walt Disney Films.



**CURRICULUM AREA:** Science - Origin of the Earth
Earth Science - Evolution

**PURPOSES:**

To depict the earth and its inhabitants as they have evolved through the ages.

To portray the beauty and wonder of creation through art and music.

**SYNOPSIS:**

"A World Is Born" presents an artful, animated picture of the Earth, from its birth as a bubble from our sun billions of years ago to its present stage, and its probable future.

In the early stages, the crust of the earth upheaves, volcanoes erupt and lava flows. Water, in the form of rain, forms oceans in which living cells divide and grow, develop into colonies of cells, and then into worms as ages roll by. The fish evolve; some come out of the water and develop into amphibians and then into reptiles.

The "Survival of the Fittest" theory of evolution is dramatically portrayed by showing how animals who are "careless ones are careless once" because they are destroyed by those more fit.

The accompanying music throughout the film is expressive in its own right, as well as supportive of the pictorial story. Classical pieces from Disney's "Fantasia" are utilized. Stravinsky's "Ritesof Spring" enhances the action in the life struggle scenes.

**PREPARATION OF THE CLASS:**

To enable students to place properly the events they see in the perspective of time, and to provide a frame of reference for meaningful viewing, the teacher might outline the following time scale on the chalkboard:

| Years Ago | Characteristics of the Time |
|---|---|
| 4½ billion | The earch emerged as a gaseous body. |
| 2-1 billion | The earth cooled down through the molten stage to a temperature that would support life. |
| 1-½ billion | One-celled marine organisms emerged. |
| 400 million | Many forms of marine life were present (according to fossil findings). |
| 300 million | Dinosaurs were dominant. |
| 100 million | Mammalian groups emerged. |
| 1 million | Man-like beings emerged. |

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- Condition of the earth in its initial stage.
- Early living forms.

- Stages through which animals are thought to have evolved.
- How the "Survival of the Fittest" theory is illustrated.
- The beauty and wonder of creation.
- How the music supports the action in the animated illustrations, especially in the life struggle scenes.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

1. One way of having students recall and review the film's major aspects would be to refer to each stage in the time scale in this guide and ask how the events were portrayed.

2. To emphasize that the presentation was based on scientific theories, you might discuss with the class:

   - What the film points out about the theory of the "Survival of the Fittest."
   - How the theory of the emergence of life is presented.

SUGGESTED RELATED ACTIVITIES:

To further reinforce ideas presented in the film, the class might discuss:

- How the water cycle began and why it is important.
- Why scientists believe that life began in a period preceding that from which we have fossil records. (Early animals were simple-structured; soft-shelled marine life left no fossil records.)

SUGGESTED RELATED CREATIVE ACTIVITIES:

To further awaken sensitive students to the beauty of the creation and the wonders of natural phenomena, as well as to enhance knowledge of earth's history:

- Have some art-talented pupils produce depictions of the earth at its various stages of development.
- Select some of the student-made depictions, some slides or some projectuals illustrating the evolution of the earth and/or its life forms. Ask interested students to choose recordings to enhance the mood and feeling of the pictures.
- Have children listen to "The Rite of Spring" with emphasis on the understanding that Spring is a time of rebirth. Spring may be likened to adolescence - a time of flowering and change in the human being, in preparation for maturity.
- Music (especially Baroque vocal forms) often centers about the wonder and glory of creation in works written to the glory of God. Hayden's "Creation" is a prime example. Playing of excerpts from this work would make for an excellent follow-up experience.

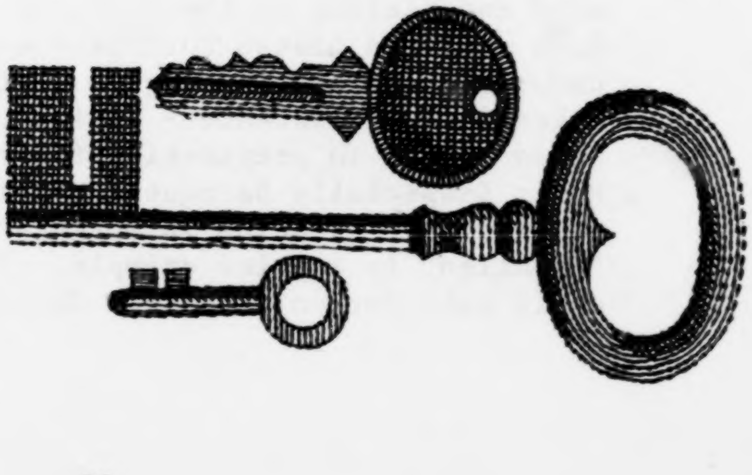
- Explain that artistic forms, just as biological forms, come to a point at which the environment is no longer suitable for their survival. Thus, the massive instrumental and choral works of the later 19th century (operas of Wagner, Berlioz's Requium, extended works of Richard Strauss) gave way to simpler forms (short sonatas, art songs) in the early 20th century. The complex fugues and other polyphonic forms of the Baroque period gave way to the simpler homophonic forms of the classical period. In dance, a new "form," modern dance, challenged ballet for survival.

**RELATED MATERIALS:**

**Film:**

The Dinosaur Age. (Film Associates of California)

This film gives an excellent account of life on earth during the period when dinosaurs reached their peak.



**CULTURAL ITEM:** "PREHISTORIC ANIMALS OF THE TAR PITS" (Film)
Film Associates of California
14 minutes, color.

**CURRICULUM AREA:** Earth's Evolution
Earth Science - Fossilization - Paleontology

**PURPOSES:**

To demonstrate the work of the paleontologist.

To portray life 40,000 years ago in the La Brea Tar Pit area.

**SYNOPSIS:**

In the tar pits of La Brea, California, paleontolgists have uncovered a wealth of information about prehistoric animals. Through excellent animated diagrams and illustrations, we are shown the way in which scientists believe the tar pits originated by being squeezed up from underground.

The paleontologist's work of sorting and cataloguing fossil discoveries is demonstrated. A theoretical view of La Brea about 40,000 years ago shows some of the animals which lived in the tar pit area, (camel, mastodon, mammoth, terrataunus, giant sloth, saber-tooth tiger), and the dramatic way in which these animals probably became trapped and fossilized in the pits.

**SUGGESTED PREPARATION OF THE CLASS:**

To make students aware of the importance of fossils as clues to past life, the teacher might explain that plants and animals have been preserved in tar, wax, coal, ice and stone, and that such clues may be in the form of shells, bones, tracks, eggs, imprints or entire mummies.

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- Ways in which scientists believe the tar pits orginated.
- The things paleontolgists learn from these fossil discoveries.
- Types of prehistoric animals of 40,000 years ago.
- How the film's music emphasizes the drama of the trapping of the animals in the tar pit.

**PRESENT MEDIA.**

**SUGGESTED FOLLOW-UP ACTIVITIES:**

How the tar pit fossils originated and how the paleontologist finds and interprets fossils may be reviewed by eliciting the steps involved from the trapping of a prehistoric animal to its discovery, interpretation and display by a paleontologist. The steps might be written on acetates with grease pencils and projected by an overhead projector in the proper sequence.

To recapitulate, the following or similar questions might be asked:

- What are fossils? What are some ways in which they are formed?
- What do fossils tell us?

- How old are fossils at La Brea?
- What is a paleontologist?
- How do paleontologists help us reconstruct our ideas of the world's past?
- What are some of the prehistoric animals of the tar pits? How did they come to be there?
- How are paleontologists able to date prehistoric animals (radio carbon dating)?
- What type of climate must there have been at La Brea at one time in the light of the presence of camels?

**SUGGESTED RELATED ACTIVITIES:**

1. Discuss the work of related scientists. Compare the work of the archeologist and the paleontologist:
   - What does the archeologist learn about past peoples from their tools?
   - What conclusions can be reached about early man from his cave-drawings?
2. The scientific basis for radioactive dating with carbon should be explained to help students understand how fossils are placed in time.

   All living plants and animals take in radiocarbon from the air. By checking the radioactive emission rate from fossil remains, paleontologists and archeologists can tell how long the object has been decaying.

   Cosmic radiations entering the atmosphere smash atoms in the air, resulting in various atomic particles, one of which is the neutron. When neutrons collide with nitrogen atoms in the air, they cause the nucleus to emit a proton resulting in a radioactive carbon atom. This radio carbon has a "Half-life" of 5,600 years.

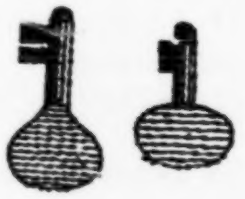
   Since we can tell the number of disintegrations given off per hour from a living organism, we can date a fossil remnant by its amount of radioactivity because we know that the number of the disintegrations will decrease by one-half the original amount every 5,600 years. By this method, scientists can date prehistoric organisms to around 40,000 years ago.

   Carbon dating is an important method of placing artifacts in time found by the archeologist. Thus both paleontologist and archeologist help the scientist and historian reconstruct the past. By knowing about the past, both in nature and in history, we can prognosticate about the future.

**RELATED MATERIALS:**

Films: "World is Born" - Walt Disney Films
20 minutes, Color.

"The Dinosaur Age" - Film Associates of California
20 minutes, Color.



Book: Evolution - Life Nature Library

**CULTURAL ITEM:** "GRAND CANYON" (Film)
Walt Disney Films, 477 Madison Ave., New York City
29 minutes, color.

**CURRICULUM AREA:** Science - Changes in the Earth's Surface
Learning to observe what rocks can tell us.

**PURPOSE:**

To enhance the viewer's esthetic appreciation of this natural wonder.

**SYNOPSIS:**

The Grand Canyon is well known for its impressive beauty, its towering buttes, mesas, and the valleys within its main gorge. Located in Arizona, where it is continually being eroded by the Colorado River, this wonder of nature has been in the formative stage for about one million years, according to geological estimates. Evidence found in the rocks of the canyon wall indicates that for long periods of time the canyon area was the bottom of a shallow sea. Although the canyon itself is of recent origin by geological standards, the rock layers are dated, beginning at the top of the canyon and continuing to the bottom; the rocks in the lower strata have been found to date back to the Pre-Cambrian era, which makes them between a half-billion and a billion years old. The canyon, over two hundred miles in length, has depths of over one mile. In this film, a panorama is displayed of this wonder of nature, which has been rightfully named one of the seven wonders of the world. The music of "Grand Canyon Suite," by Ferde Grofe, contributes greatly to the message of the film.

**SUGGESTED PREPARATION OF THE CLASS:**

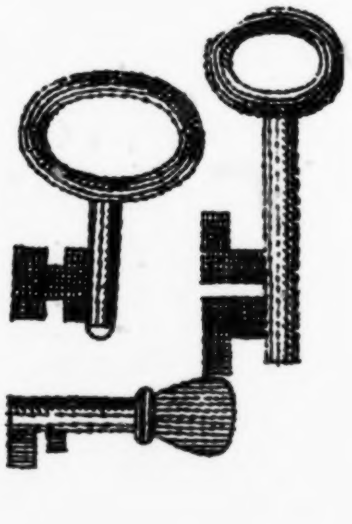
To help the student appreciate the perhaps one-billion-year-old lower layer of Grand Canyon rock, you might draw a time line on the chalkboard representing one billion years. With the aid of the class, subdivide the line so students can compare their life span with the age of the oldest rock exposed in the canyon.

A folksaying about the Colorado River's erosive action states that its water "is too muddy to drink, but not muddy enough to farm." A discussion of the meaning and implications of this saying might enable the pupils to comprehend the enormous quantities of earth that can be carried away by running water.

**STUDENTS SHOULD LOOK AND LISTEN FOR:**

- Variety of hues in rock formations.
- Different kinds of plant life.
- Rock features indicating considerable faulting.
- Color, pattern, and texture in the rock and mesas.
- The awesome beauty of nature.
- The music of the "Grand Canyon Suite," by Ferde Grofe.

**PRESENT MEDIA.**



## SUGGESTED FOLLOW-UP ACTIVITIES:

To develop facts and concepts introduced in the film, discuss with the class:

- Different climatic regions in this area have given rise to different types of vegetation. What are some types of vegetation you saw?
- Which animals find a natural habitat here?
- What influence do you think radioactive dating has had on our understanding of this land formation?
- In what ways has this area aided geologists in their quest for knowledge?
- How do you think this natural beauty might have inspired Grofe's musical composition?
- How would visiting the Grand Canyon make you feel the vastness of nature and the smallness of man and his accomplishments?

## RELATED CREATIVE ACTIVITIES:

Have pupils arrange a bulletin board display which depicts the various eras through which this land formation has evolved.

Made a roll (picture-strip) of some inspiring aspect of nature for projection on the opaque projector, containing comments and musical background which suit the projected pictures. Play tape as picture roll is projected.

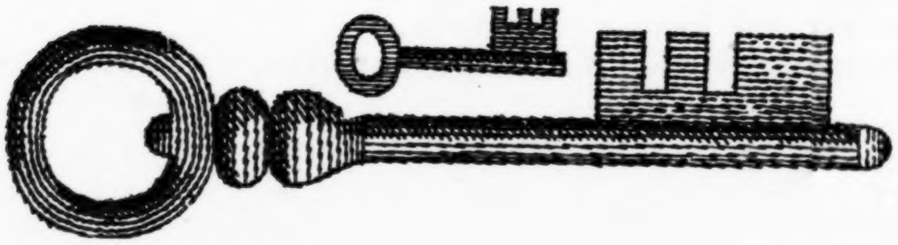
## RELATED MATERIALS:

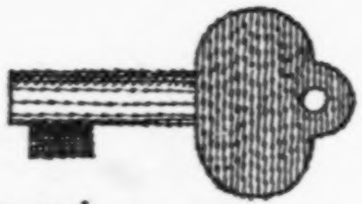
### Films:

"Canyon Country" - Ford Films
14 minutes, color.

### Filmstrip:

National Park of the United States Series, S. V. E.





**CULTURAL ITEM:** "THE ARTIST AND NATURE" (Film)
10 minutes, color, Bailey Films.

**CURRICULUM AREA:** Science - Learning to observe structure form and pattern in nature.

**PURPOSES:**

To awaken students to beauty in their surroundings and make them more aware of materials, forms and structures.

To stimulate original thinking and creativeness.

**SYNOPSIS:**

This sensitive film shows the pattern and beauty of nature by calling attention with the eye of the camera to form, design, structure, color, line and volume. Interpretations of nature by artists are also shown. Observation and perception - "seeing" forms patterns and relationships - are a vital part of scientific investigation, as well as of creative original thought. Experiences like those shown in this film may stimulate both.

**SUGGESTED PREPARATION OF THE CLASS:**

To show the pertinence of the film, explain that although few of us will become professional artists it is wise for us as science students to learn to see with the unique vision of the artist. Artists, like scientists, observe nature closely and see things in new, different and original ways. Careful observation plays a vital role in science. Learning to see new patterns and new relationships is an important aspect in moving science forward to new discovery and breakthrough. This film can help educate our eyes so that we really "see" instead of merely looking and assists us to feel and to enjoy beauty and nature. It can help us learn what to look for and how to interpret what we find.

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- The power and delicacy of the wave in Hokusai's painting.
- Patterns and textures in nature.
- Design and structure in nature.
- Shape, mass, color, lines.

**PRESENT MEDIA.**

**SUGGESTED FOLLOW-UP ACTIVITIES:**

1. To put the new-found sensitivity to work, take a "looking" walk, either as a class or individually, to note art in nature:
    - Study trees, on the looking walk or from the window or photographs. Where do they show their strength? Their delicacy?
    - Study textures. Arrange an exhibit of textures produced by nature and by man. Feel these textures.
    - Hunt for fine and heavy lines in natural forms. Which are active? Which restful?

- Find exciting shapes in nature - mountains, hills, dunes, driftwood, rocks. Arrange an exhibit of shapes you like.
- Find examples of outside framework (e.g., eggshell) produced by nature and man. Study planes in mountains and architecture.

2. Have a panel discussion on "why it is important for me to develop my powers of observation in order to enjoy and appreciate the world about me as well as to become more perceptive in my work and social relations."

SUGGESTED RELATED ACTIVITIES:

Further sharpen student perception by the following or similar activities:

1. Group students to arrange the following exhibits for class observation and use:

   - Found objects exhibiting textures and design, such as tree bark, driftwood, stones, clay, metal, plastics.
   - Colors in nature - leaves, stones, wood, feathers, fish, flowers.
   - Line in nature - photographs showing shorelines, sandlines, waves, arrangements of wire, rope, thread.
   - Shape in nature - photographs of mountains, sand dunes, driftwood, rocks, trees, shells.
   - Photographs of nature showing mass - mountains, rocks, also photographs of sculpture.
   - Examples of inside and outside structures such as shells, eggshells. Man-made structures of both types - thin shell concrete construction, girders, geodesic dome.
   - An arrangement of planes in a three-D construction.
   - Hand sculptures of wood or clay that are pleasant to feel and fitted to the hand.

2. Discuss and illustrate examples of design in nature to show:

   - Symmetry - man, leaves, crystals.
   - Pattern - fish scales, layers on an onion, spider web, honeycomb.
   - Form - Note how many natural forms are geometrical shapes. The iris of the eye and many flowers are a circle or are geometric shape. Crystals are rhomboids, polyhedrons, hexagons. Many fruits are spherical, snail shells and goat horns are spiral.

   Ask students to observe other geometrical shapes in nature.

3. Exhibit CUE display of "the shell as an art form" and microphotography of crystal formation. Explain that the artist constantly refers to nature for inspiration. Ask students to look at paintings for natural forms at the National Gallery paintings, and conventionalized natural forms such as fish, birds, and so forth in textile and other designs.

RELATED CREATIVE ACTIVITIES:

1. Expose a familiar item such as a dollar bill on the opaque projector for a few moments. Ask students to recall what they have seen. Have students use the framing device to discover patterns and pictures all about them.

2. If possible, secure microphotographs of biological or inorganic material to permit students to observe and appreciate patterns, texture and design of the microcosm. (Science and Art) Use microprojector, if available, to show movement of small things.

3. Secure and display General Motors exhibit of design in microphotographs of metals and other natural materials.

RELATED MATERIALS:

Films:

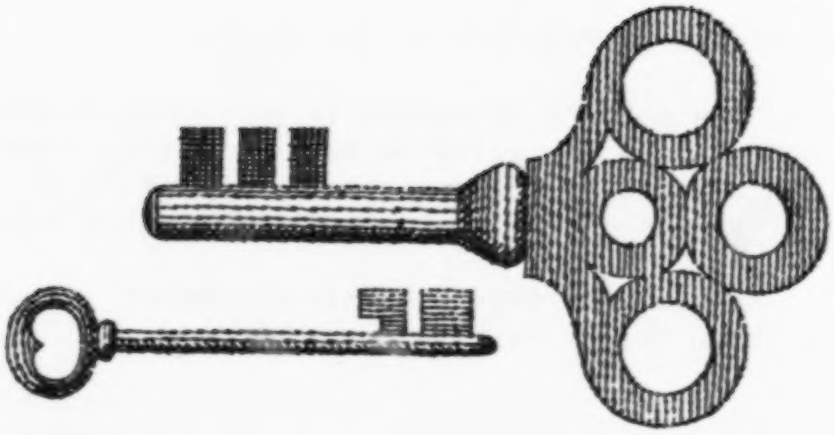
"Winter Color" - Thorne Films
"Autumn Color" - Thorne Films CUE
"World of Little Things" - Moody Institute

Books:

An Adventure in Geometry - Anthony Ravielli
Viking Press, 625 Madison Ave., New York 22, New York

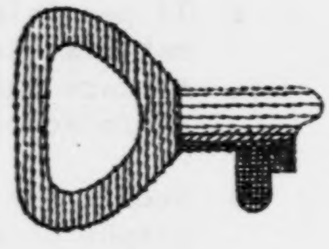
Exhibit:

The Shell in Art - Posters - CUE Science Kit
The Beauty of Crystals - CUE Exhibit of Microphotographs



CULTURAL ITEM: "NATURE'S HALF ACRE" (Film)
35 min., Color, Walt Disney Films

CURRICULUM AREA: Ecology
Photography



### PURPOSES:

To point out the beauty and drama in nature through the seasons.

To portray the struggle for survival by individuals and species.

### SYNOPSIS:

"Nature's Half Acre" represents any area which man has left relatively undisturbed. In the spring, we see various birds singing and nest-building to the accompaniment of well-suited, often humorous music (a bird doing a rhumba, a woodpecker pecking a tune on a tree). Spiders and insects are also busy building nests, laying eggs and insuring the survival of the future generations. Superb close-up photography enables us to see a moth gluing eggs to a tree, a caterpillar making a quick meal of a leaf. Mother love is amusingly represented through the frantic efforts of parent birds to feed their insatiably hungry young.

In the summer, the bumble and honey bees are mostly occupied with nectar and pollen-gathering. We follow one honeybee through its short life cycle from an egg to an apprentice hive bee to a field bee to its death in a spider's trap. Later, the predator is stung into suspended animation by a mud dauber so that the latter's eggs will have food when they develop. Other predators are featured: insectivorous plants, ant lions, preying mantises, and toads and chameleons, with their lightning-fast tongues.

In the late fall, the mantis' nest and the chrysalis are focused upon as signs of preparation for the next season, winter, when snow and ice cover everything and active life is suspended until its reawakening in spring.

Time-lapse photography is utilized to telescope the emergence of the flowers from buds to the accompaniment of orchestral music. The butterfly emerges from its chrysalis; the ending is but a beginning.

### SUGGESTED PREPARATION OF THE CLASS:

1. The balance of nature is portrayed in the film through examples which the pupils may perceive better if they clearly understand the concept. This could be accomplished by eliciting or relating some of the many illustrations of disruptions of the natural balance such as:

- How rabbits imported into Australia , encountering no natural enemies, have become serious pests there.

- How the Mexican cotton boll weevil, which was kept in check by its natural enemies in Mexico, multiplied enormously when farmers in our southern states planted thousands of **acres** of cotton.
- Other imported insects which have disturbed the balance of nature, such as the European corn borer, the Japanese beetle, the Mediterranean fruit fly.

2. The photographic techniques deserve **particular** attention. For example, time - lapse and close-up photography uncover the wonder and beauty of things too slow or too small to be fully enjoyed without these aids. Explain the operation of these techniques to the class to increase student appreciation of these photographic devices.

PUPILS SHOULD LOOK AND LISTEN FOR:

- Melodious bird songs accompanied by orchestral music.
- Closeup of a moth gluing its eggs to a tree.
- A caterpillar chewing up a leaf.
- The "formula" which a mother hummingbird injects into its young.
- The egg-deserting cowbird.
- The pollen dance of the honeybee.
- The fight for survival between a mud dauber and a spider.
- Insectivorous plants.
- How the ant lion snares ant stragglers.
- The cannibalism of the preying mantis.
- The lightning-fast tongue of the chameleons.
- Insects in various stages of their life cycles.
- Time-lapse photography and music emphasizing the emergence of flowers from their buds.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

- The way each group of animals and plants seeks to perpetuate itself is beautifully demonstrated throughout the film. A chalkboard listing elicited from the students might aid in recalling the scattered instances such as that of bud-formation, flowers, and pollination in the plant world, and egg-laying, egg-tending, feeding and caring of the young among animals.
- Discussions of illustrations of predation might give further meaning to the concept of balance of nature. This would also be a good time to enable the pupils to understand that their anthropomorphic hatred of the predator, and sympathy for the animals preyed upon, is **unconscious** and demonstrates a lack of comprehension of the importance of the balance of nature to those preyed upon as well as to the predator.
- Discuss how some scientific answers to problems cause other problems such as the killing of much plant and animal life as a result of the use of pesticides.
- Discuss how is the "balance in nature" being **upset** by man?: Destruction of wild life through destruction of forest, jungle; Insecticides which may kill large percentages of particular insects and other life (such as fish in the rivers) needed to maintain this balance.

SUGGESTED RELATED ACTIVITIES:

- To impress upon students the necessity for conservation of natural beauty and wild life, show the CUE film "Let's Keep America Beautiful" and anti-litter pamphlets. Discuss necessity for conservation.
- Use Life Tearsheets to show how photographers have captured some of this natural beauty.

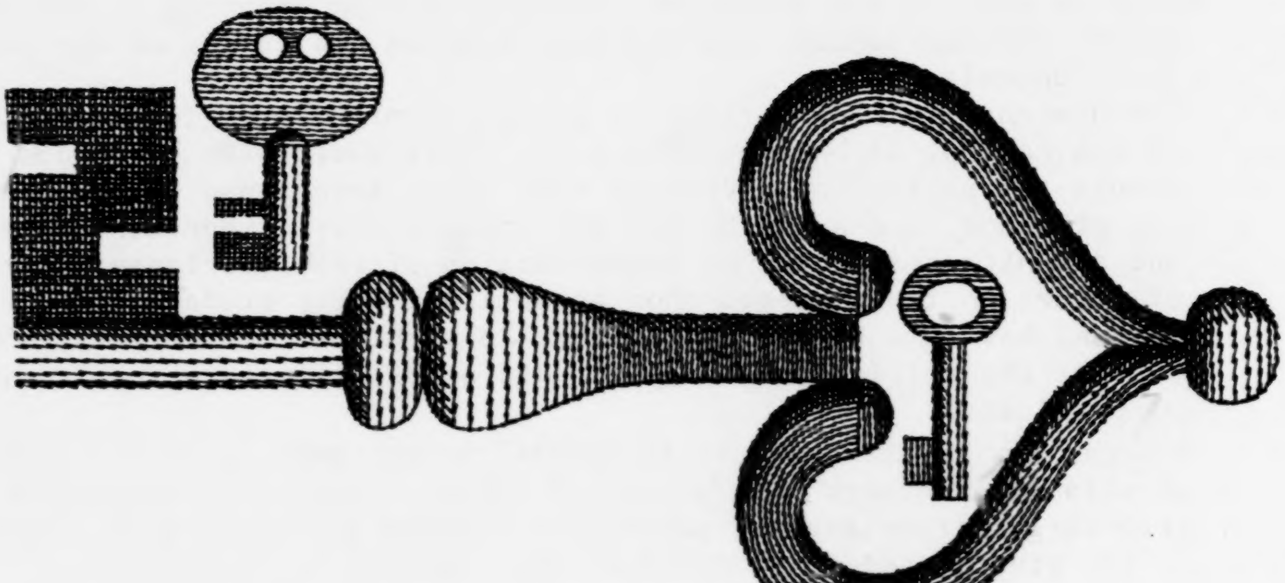
SUGGESTED RELATED CREATIVE ACTIVITIES:

- Some pupils who practice photography as a hobby may wish to display their photographs which attempt to capture some of the beauty of nature.
- Students may make contact prints of ferns, leaves or other natural materials.

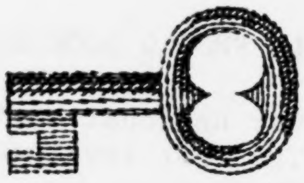
RELATED MATERIALS:

Films:

Let's Keep America Beautiful. (CUE)
Secrets Of the Bee World. (Walt Disney Films) (CUE)
Social Insects: The Honeybee. (Encyclopedia Britannica)
City of the Bees. (Moody Institute)
Animal Habitats. (Film Associates of California)



**CULTURAL ITEM:** "LET'S KEEP AMERICA BEAUTIFUL" (Film)
16 min., Color, Richfield Film Co.



**CURRICULUM AREA:** Science

**PURPOSES:**

To show students how careless highway housekeeping habits mar our country's beauty and waste millions of dollars.

To help them realize that most littering results from virtually unconscious acts.

To help them realize their own culpability and to change their attitudes.

**SYNOPSIS:**

America has great natural beauty and scenic grandeur. No matter where you look there is something to delight the eye. But often this rich storehouse of beauty is marred by the trash left by the litterbug.

We do not realize it but the litterbug lives in all of us. Less than one percent of it is intentional. Yet week by week, we scatter enough trash to obliterate highways and beauty spots completely. Fifty million dollars is spent each year to clean highways. To keep parks and highways clean for only one weekend costs 100 million dollars - money that could be spent for education and advancement of our nation.

What is the answer? Laws and fines? These take care of a few. The real answer lies in giving your actions conscious thought each day and eliminating littering habits so that we can restore to our country its heritage of beauty.

**SUGGESTED PREPARZTION OF THE CLASS:**

1. To alert students to our national heritage of beauty, show and discuss one or two CUE (SVE) "National Parks and Monuments" filmstrips related to the area of the country they are studying, or flat pictures of national beauty spots.

2. To help students understand that one of our country's biggest problems is waste of natural resources, and destruction of natural beauty, explain that although our country has vast resources, criminal and unintentional waste of these resources is so great as to endanger our economic future. Have them help you list ways in which resources are wasted or poorly cared for. Bring out the fact that it is the students themselves who are often the guilty ones. This film will show them why.

3. Show pictures of littered streets, or call attention to local eyesores caused by carelessness - (use booklets in CUE Science Kit).

4. Discuss how repeated acts may become habitual and therefore automatic and unconscious.

PUPILS SHOULD LOOK AND LISTEN FOR:

- Our national heritage of beauty, and who mars it.
- The cost involved in cleaning up litter.
- The guilty ones.
- The unconscious nature of the littering habit.
- How to stop litter.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

To further drive home the film's lesson, discuss:

- How one scrap of paper thrown away by each person can mean millions of dollars in clean-up costs.
- How litterers penalize themselves taxwise besides marring beauty.
- How they can keep their school and neighborhood and highways clean.
- How bad habits (littering) can be replaced by good habits (properly disposing of litter) through awareness of bad acts and repetition of good acts.

SUGGESTED RELATED ACTIVITIES:

1. Show other CUE SVE National Monument filmstrips. Discuss how we try to preserve this beauty.

2. Conduct a clean-up campaign.

3. Have students make a bulletin board showing national resources being wasted and write papers on how to cut down or avoid this waste.

RELATED MATERIALS:

Films:

"Arteries of Life" - Encyclopedia Britannica Films
" Birth of the Soil" - Encyclopedia Britannica Films
"Conservation of Resources" - Encyclopedia Britannica Films

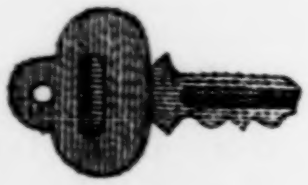
Booklets:

CUE Science Kit.

Filmstrips:

"What is Conservation" - Encyclopedia Britannica Films
"Forest Fires" - (SVE)
"National Parks and Monuments of the United States" - (set of 5 filmstrips)
  "National Parks of the Southwest U. S."
  "National Monuments of the Southwest U. S."
  "National Parks and Monuments of the Eastern U. S." (All available from
  "National Parks of the Northwest and Pacific Coast States" Project CUE.)
  "Yellowstone National Park"

**CULTURAL ITEM:** "SECRETS OF THE BEE WORLD" (Film)
Walt Disney Films
13 minutes, Color.



**CURRICULUM AREA:** Science - Living Things. (adaptations)
Becoming aware of the organization of an insect society.

**PURPOSES:**

To develop the understanding that insect behavior is instinctive.

To stimulate an awareness of similarities and differences between the societies of man and of insects.

To stimulate students to think about the organizations of societies.

**SYNOPSIS:**

The film shows a hive of bees through the seasons. With high quality nature photography, spectacular close-ups, dramatic narration and effective mood music, it demonstrates the high degree of specialization involved in the activities vital to the colony's survival.

The queen bee is the central figure, as she alone can lay eggs (about two thousand a day and about one million in her lifetime). The eggs, in architecturally marvelous hexagonal wax enclosures, are nurtured by hive worker bees with honey provided by field workers, who are shown during the "spring gold rush."

The queen leaves the hive in winter, taking with her part of the colony and forming a swarm. Now workers in the old hive feed some of the eggs a special "royal jelly" which enables them to develop into "queens," one of which kills her rival sisters either while they are still in their cells or in a dramatic "fight to the finish." The drones, males which are useless for the most part, now perform their one important function, racing into the sky to impregnate the queen in a "wedding flight" so that more eggs can be produced.

Drama enters the story when a forest fire rages in the vicinity. The bees desperately strive to keep the honey combs from melting by cooling the hive with their rapidly beating wings. A happy ending ensues; the hive is miraculously spared.

**SUGGESTED PREPARATION OF THE CLASS:**

Help students avoid the tendency to attribute human reasoning and feelings to behavior patterns of animals (anthropomorphism) by discussing what anthropomorphism is and why it hinders unbiased scientific observation. Ask them to record examples of anthropomorphic language in the film (the bee's "alarm," "confusion," "prime concern" and "courage"). Point out, however, that anthropomorphisms are useful as story-telling devices or in effective analogies. George Orwell's "Animal Farm" is an allegory which combines common human misinterpretations of animal behavior.

Who hasn't been stung by a bee? Students may be impressed by the fact that a bee sacrifices its life by stinging. A discussion of the unimportance of the loss of an individual compared with survival of the group might be stimulated; students might consider the varying importance of the individual in different societies. Available realia such as hives, combs or domestic colonies would help develop the discussion.

## PUPILS SHOULD LOOK AND LISTEN FOR:

- How the queen is the central figure.
- How bees make honey.
- The architectural marvel of the honeycomb construction.
- How the bee world is perpetuated.
- The division of labor in the colony.

## PRESENT MEDIA.

## SUGGESTED FOLLOW-UP ACTIVITIES:

1. List anthropomorphisms contributed and elicit a possible scientific explanation for each. For example:

| Anthropomorphism | Possible Scientific Explanation |
|---|---|
| The bees are "alarmed and confused by the heat of the forest fire." | The greated temperature might have increased general activity on the part of individual bees. |

2. To summarize the film's major points, compare bee society and human society by discussing questions like these:
    - Why are bees and humans termed "social animals?"
    - To what extent does human society possess division of labor and specialization of function?
    - How does each society pass its culture to future generations?
    - How does each society differ in its perception of the world around it?
    - How does the Hebraic concept of the importance of the individual affect the government of a society?

## SUGGESTED RELATED ACTIVITIES:

To widen understandings of material presented, explain:

- The goal of maximum storage capacity with minimum space achieved by the hexagonal cells of the honeycomb is applicable to virtually all architectural design problems of the industrial arts, and to the division of mathematics called "group structure."
- Honeycomb walls are one-eightieth of an inch thick but can support thirty times their own weight. How does the hexagonal structure contribute to this strength?
- Show pictures of Fuller's "geodesic dome" and of concrete shell construction. Contrast the cost and weight and time involved in building these and older style structures.

## RELATED CREATIVE ACTIVITIES:

(NOTE: Anthropomorphically - based allegories, like Orwell's "Animal Farm," can be written by students for their language arts class.)

To stimulate creative thinking:

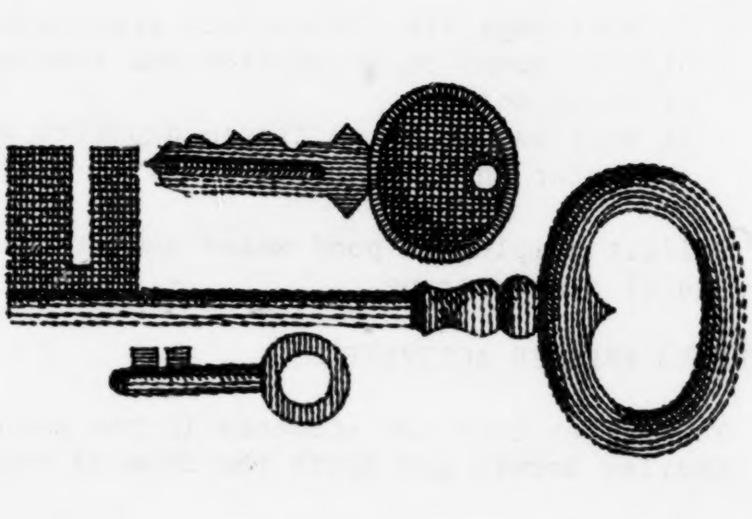
. Ask students to study structures made by bees and other insects and animals to see if they can develop a structural idea from them. (A snail's shell is reminiscent of a spiral stairway or of the plan of the Guggenheim Museum.)
. Study other natural forms, like plants and snowflakes, as a source of inspiration for structural or other design (wasp's nest, spider web).
. Lead students to understand that structures result from needs of the builder. Have students list their living, working and studying needs. Then have them study their classroom, home or school, and suggest how to improve it structurally to fit those needs.

## RELATED MATERIALS:

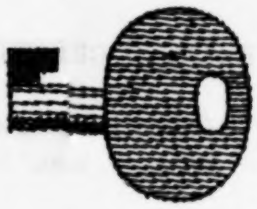
Films:

"Social Insects - The Honey Bee"
Encyclopedia Britannica Films

"City of the Bees"
Moody Institute of Science



**CULTURAL ITEM:** "WORLD OF LITTLE THINGS" (Film)
10 min., B&W, Moody Institute



**CURRICULUM AREA:** Biology - A Look into the Microcosm

**PURPOSES:**

To assist students to understand how we think life began; how creatures evolved.

**SYNOPSIS:**

Microphotography allows us to look into the microcosm to see the life, structure and activities of tiny animals in this unusual film which may be used to introduce the study of animal life.

**SUGGESTED PREPARATION OF THE CLASS:**

Explain to the students that although no one can say for certain how life began on earth, scientist theorize that all life began as a simple one celled structures which eventually grouped together to function as a single entity. As time progressed there were gradual adaptations in form and structure of these early organisms to their surroundings. These adaptations and changes enabled them to better survive.

Darwin's research led him to believe that all life evolved from the same ancestry; that differences among creatures are the result of these adaptations to conditions of their surroundings.

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- Structures of simple animals and their methods of locomotion.
- Interdependence of simple animals in colony life.
- Reproductive processes and protective mechanism in simple animals.

**PRESENT MEDIA.**

**SUGGESTED FOLLOW-UP ACTIVITIES:**

1. In order to stimulate thought about the film content ask:
    - In what ways are microscopic organisms similar to living things we know?
    - Discuss means of locomotion and feeding habits and protective mechanisms of these animals.
    - In what way do large diatom deposits help us explain the distribution of sea water in prehistoric times?
2. Collect samples of pond water and study the various animals in it with the use of a microscope.

**SUGGESTED RELATED ACTIVITIES:**

To further interest students in the study of biology explain: In 1859 Charles Darwin set forth the idea of the evolution of man -- the idea that all living creatures are products of a process of evolutionary development. But man has not only evolved, he is still evolving. Human evolution is not all in the past, it is an actuality and a concern for the future.

Man has always exerted more efforts to control the forces of inanimate nature than he has to understand himself and the world of life of which he is a part. The discovery of atomic energy has increased popular appreciation of science. The possibility of human genetic damage from radiation exposures is only one of the pressures which are causing the study of the biological sciences to surge ahead.

Radiation fallout however, is only a relatively minor part of a more serious and vastly greater problem of the maintainence of the genetic health of the human species. It is becoming more and more evident that man can no longer solely rely on Darwinian natural selection and other natural processes to cope with the hazards of the environment in which he lives.

Here mankind faces possibly the most portentious challenge of its whole history as a biological species. The time is not far off when mankind will have to regulate his numbers and control his genetic patrimony in order to sustain bodily and mental vigor. It is vital then for us to learn more about the biological processes and their sociological implications.

Secure the Life Nature Library Book on Evolution to show:

- Darwin's "Voyage to the Galapagos" and the results of seclusion of animal life there.
- Project pictures to show how isolation of the peoples of Tierra de Fuego produced different adaptations.
- Project picture of man made evolution in flowers and animals. Project and discuss ancestors of man such as the Piltdown man.
- Project and discuss the man-like apes and their family patterns.
- Project "The Primate Tree" and the "Races of Modern Man."

Show the CUE filmstrip "Color of Man" to further explain to students how a relatively minor hereditary factor can change the appearance of persons.

RELATED MATERIALS:

Films:

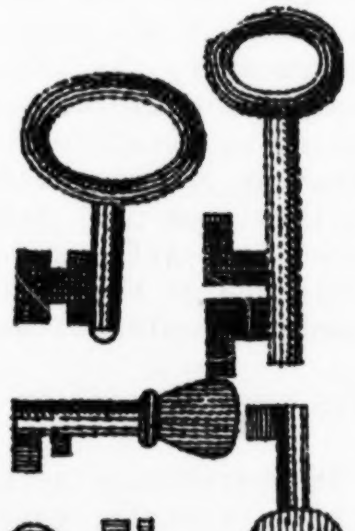
"Brotherhood of Man"
"Prehistoric Animals of the Tar Pits"

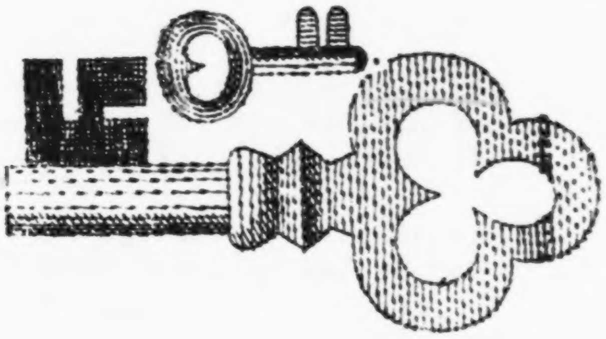
Filmstrip:

"Color of Man" - University of California

Book:

Life Nature Library Evolution Time Inc. 1962





**CULTURAL ITEM:** "COLOR OF MAN" (Filmstrip)
University of California
50 frames, Color.

**CURRICULUM AREA:** Anthropology

**PURPOSES:**

To acquaint students with underlying reasons for variation in skin color and thus to promote better human relations.

**SYNOPSIS:**

This filmstrip explains differences in color among men on the basis of hereditary differences in the ability to produce melanin which absorbs untraviolet rays before they can injure the skin.

At the equator where ultraviolet is strongest, high melanin producing people survived best.

In the northern rain forests low melanin producers who could absorb sufficient vitamin D from the weak ultraviolet present in the higher altitudes survived best. After thousands of generations a color latitude relationship sprang up because movement was limited to a small area by insurmountable natural barriers. Today advances in chemistry and communications are weakening the color selective power of the environment.

**SUGGESTED PREPARATION OF THE CLASS:**

To awaken students to the importance of this lesson display pictures of race riots and civil rights protestors. Explain: Many grave social problems in history, causing much bloodshed, suffering, death and injustice, are caused by simple ignorance of scientific facts. As a result, ignorance, suspicions, superstitions and prejudices arise.

In primitive times men were limited to small areas because of mountains or oceans they could not cross. People lived in isolated groups and developed their own habits, customs and ideas adapted to their particular environment and culture. Even their skin color was determined by their environment. As transportation improved and population increased, these groups of different peoples encountered each other. It is natural for man to be afraid of things which are new and different. Lack of understanding of the causes of these differences led to wars and troubles which still plague us. Today, however, we know that basically all men are the same. All differences are slight and superficial. This film will illustrate one of those differences which is causing so much strife in our country - color of man.

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- The hereditary aspect of ability to produce melanin which prevents burning by ultraviolet rays.

- How lack of ability to produce melanin makes life difficult in the tropics.
- Why dark eyed people tended to survive in the equatorial zone.
- Why people with less melanin survive better in the weak ultraviolet of Northern rain forests.
- How and why latitudinal color relationship developed.
- Why the selective power of the environment is weakening.
- Why it is important to understand these small differences.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

To insure understanding of the facts presented in the film discuss with the class:

1. How a very minor hereditary factor caused color differences.

2. The selective power of evolution and the environment in causing color differences.

3. Why the environmental factor is weakening because of vitamins, travel and intermarriage.

4. The variety of color differention within a race, e.g. many of the so called white or red races are darker than the fairer negroes. Explain: Many peoples and rulers have liked to invent myths such as the divine right of kings in order to gain power over others.

   Hitler and others have tried to establish the myth of white supremacy when in actuality tests have shown that racial differences of individuals have little bearing on IQ, culture or progress. A Negro skeleton can hardly be distinguished from that of a white person; their blood types are the same. The idea of a pure race is fictitious. American Negroes are said to have 90% admixture with whites in varying proportions.

   If one isolates a factor such as intelligence there is a wider differential within one race than between races in general.

   Most "differences" between peoples are culturally derived rather than inherent. Culturally derived differences are and can be affected and changed through such factors as education, institutionalized reorganization and social reforms.

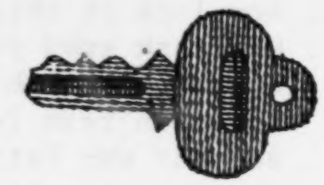
SUGGESTED RELATED ACTIVITIES:

1. View the CUE film "Brotherhood of Man" and "Boundary Lines." Discuss how ignorance of simple scientific facts and lack of understandings of other cultures have caused trouble throughout time.

2. Have students research and write papers on "How Science Can Contribute to Social Progress."

3. Have a panel discussion on "How Science Proves the Oneness of Mankind."

CULTURAL ITEM: "A LIGHT IN NATURE" (Film)
35 min., Color, Shell Oil Company



CURRICULUM AREA: The Nature of Science
Research in all Branches of Science

PURPOSES:

To demonstrate the role of the philosopher and the scientist throughout history, as measurer, questioner and reasoner from facts.

To provide a world-wide guided tour of scientific research.

SYNOPSIS:

Past and present scientific quests of the Royal Society of London around the world provide illustrations of the methods of the scientist in exploring the mysteries of our universe.

Through British-accented narration, we learn that the film's title is derived from Francis Bacon's assertion that all most hidden and secret could be disclosed by man's "kindling a light in Nature." We see Descarte's advise, "Order your thinking" being utilized by today's scientists, who, like their predecessors, arrange their thoughts, begin with simple objects or ideas, diligently inquire into the properties of things, and proceed slowly from hypothesis to the explanation.

Science is shown at work on the frontiers of knowledge; from satellites orbiting in space to the bathyscape probing the ocean depths, from nuclear research in Bombay to I.G.Y. activities in the frozen North, from the electron microscope searching for infinitesimal flaws in metal flakes to the 200-inch telescope seeking information on the birth and death of stars, from the operation of complex computers to experiments which endeavor to understand the operation of the human brain, from the attempts of Ptolemy, Copernicus, Brahe, Kepler, Galileo and Newton to discover the pattern of the universe to the attempts by modern scientists to decode D N A to disclose the pattern of life.

Still and animated illustrations and coordinated music are employed to help provide the background, history and expansion of some of the topics considered.

SUGGESTED PREPARATION OF THE CLASS:

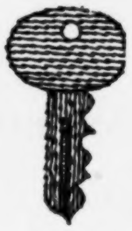
Since this film has a rapid pace and British narration it would be wise to be especially specific as to the items students should look and listen for.

To insure comprehension of an important concept presented concerning the necessity for the scientist to cooperate with others in his own and related fields, the teacher might ask:

- Why a scientist working alone is likely to be greatly handicapped?
- Why a researcher who did not adequately investigate the findings of past researchers would be likely to be wasting time?

### PUPILS SHOULD LOOK AND LISTEN FOR:

- Scientists of various nationalities at work.
- The "evidence to reasoning" approach by scientists.
- Advances in the field of atomic makeup.
- Investigation in the area of photosynthesis.
- Investigations for the purpose of explaining life itself.
- Motion microphotography of cell division.
- Experiments with the nervous system of humans.
- Improved exploration of the heavens.



### PRESENT MEDIA.

### SUGGESTED FOLLOW-UP ACTIVITIES:

To drive home concepts presented in the film:

- The students might apply their knowledge of the methods of scientists by preparing a report showing how a given scientist applied the "evidence to reasoning" approach to his particular discovery.

- To accentuate the interrelationship of various fields of science, you might have students recall how all the following aided in the investigation of the nucleus of the cell:

  - The X-Ray (physics)
  - The ultracentrifuge (chemistry)
  - The study of fruit flies (biology)

### INSIGHT:

To broaden student horizons regarding the part the sciences, arts play in their life:

- Assist students to understand that both artists and the scientists are studying nature seeking to find truth and order, that both science and art are spiritual activities, not practical, whatever practical applications may be derived from their results. Disorder and lack of meaning are spiritual, not physical, discomforts. Order and sense are spiritual, not physical, satisfactions. The subject and the methods of the scientist and the artist differ, but their impulse is the same.

- All students need education in both the arts and the sciences. The scientific spirit is not opposed to the esthetic, the moral or the social. It is a spirit of enlightenment, of social advance, of creative thought. "We must not do it the dishonor of isolating it as a technique."*

---

* Harold Taylor, "Art And The Intellect."

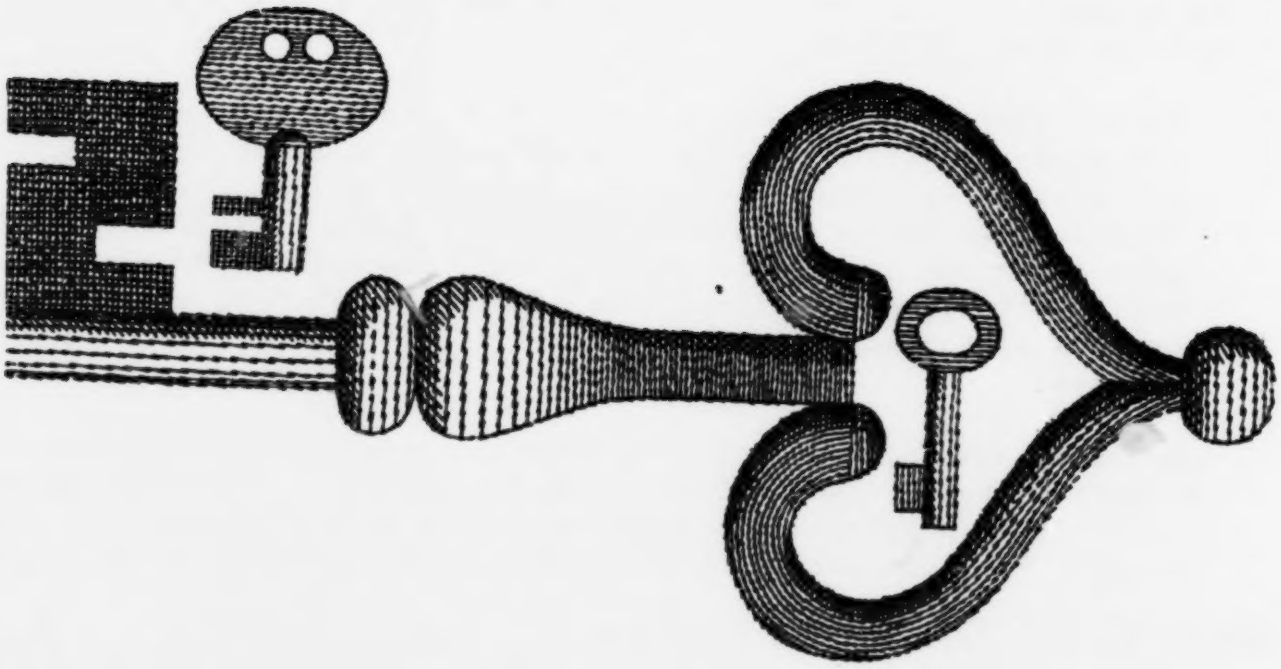
SUGGESTED RELATED CREATIVE ACTIVITIES:

- Some students might benefit themselves and the class by presenting a dramatic historical treatment of a science topic being studied by the group, using slides, taped music and narration.
- Science depends heavily on models as a means of investigating phenomena. With the cooperation of the industrial arts teacher or the art teacher, models, such as that of the D N A molecule shown in the film, might be constructed, perhaps in the form of mobiles.

RELATED MATERIALS:

Films:

About Time. (Bell Telephone Company)
Flaming Sky. (McGraw-Hill Films)



**CULTURAL ITEM:** "A HISTORY OF MEDICINE IN PICTURES" (Paintings)
(Set 1) 6 colored lithographed paintings by
Robert Thom. Parke Davis and Company

**CURRICULUM AREA:** Biology
Anthropology - Beginning of Medicine.

**PURPOSES:**

To acquaint students with the history of medicine through paintings.

**SYNOPSIS:**

Roots of ancient medicine are buried back before the dawn of history. The quality of medical service in an area has profoundly affected its civilization.

This is a series of large lithographs treating aspects of primitive and early medicine and its practices. Interesting informative notes are supplied with each painting. It is suggested that these notes be clipped and taped to the back of each painting.

**SUGGESTED PREPARATION OF THE CLASS:**

Display each picture and explain, or tape information to be heard as students view the pictures:

1. Medicine in Ancient Egypt: Egyptian physicians used many drugs but thought their effect primarily magical. Papyri which contained magic formulas, prayers and suggested treatments, such as diet, physiotherapy and drugs, were used in treating patients. Some of the drugs are still used today. Egyptian physicians were highly respected all over the ancient world.
   The Picture: The physician treats a patient in accordance with the course prescribed on a scroll.

2. The Code of Hammurabi: The Code of Hammurabi is one of the oldest known law collections promulgated by the Babylonian king, Hammurabi. This document, preserved on a slab of diorite, is grim evidence of a regular recognized medical profession existing 4000 years ago that attempted at least minor surgery, observed its legal responsibilities, and operated on a government-controlled sliding fee schedule based on the social status of the patient. The code also provided punishments for sorcerers. In Mesopotamia, divination was used for interpretation of dreams and diagnosis of disease. Case histories set down on clay tablets aided in diagnosis and treatment. Mesopotamian drug lore influenced early Greek medicine.
   The Picture: The physician defends his professional practices before the king against the complaints of a litter-borne patient who seeks invocation of the drastic penalties of the Code of Hammurabi.

3. Trephining in Ancient Peru: Peru was the center of the intensive practice of trephining (operating on the skull) in the New World. Although this practice was carried on in many parts of the ancient world, the ancient Peruvians succeeded in an operation that until the 20th Century was considered very dangerous. These operations were made because of skull wounds, to free demons, or because of the practice of shaping the skull, common among Indians. Amputations and other operations were successfully carried on, and Peru cultivated an outstanding collection of medicinal plants, including cocaine and quinine. In spite of advances, Peruvian medicine remained strongly allied to religion.
   The Picture: Obsidian glass knives, plants and prayers of priests assist at a skull operation.

4. Primitive Medicine: Members of a primitive society do not distinguish between medicine, magic and religion. They regard disease and death as the work of gods, priests, ghosts or sorcerers who have been provoked; therefore, magic must be used by the medicine man or shaman to overcome or placate the spirits. This magic may be in the form of chants, dances, rituals or herbal medicines.
   The Picture: A moment in the nine-day "Navaho Mountain Chant" is captured. This ceremony embodies all the elements of primitive medicine, religious chants, drug lore, physio- and psychotherapeutic measures, and sand painting (magic).

5. The Temples and Cult of Aesculapius: While Greek medicine had more rational scientific background, there also grew up there a religious medical cult of Aesculapius (mentioned in the Iliad), whose daughters Hygeia, Panacea, and Iaso symbolized other aspects of medicine. Temples of Aesculapius were rather like health resorts located near mineral springs with baths and gymnasiums. The god Aesculapius visited patients in their dreams and supposedly cured them.
   The Picture: Patients in the temple of Aesculapius await "incubation" in which the god visited them in a dream and cured or prescribed for them.

6. Súsruta-Surgeon of Old India: As early as 400 B.C., Súsruta, Hindu physician, compiled a work devoted to surgery, medicine, pathology, anatomy, midwifery, biology, ophthalmology, hygiene and some psychology. Hindu medicine was remarkably advanced, and spread throughout Asia and influenced Greek surgeons.
   The Picture: Súsruta is about to fashion an artificial ear lobe for a patient drugged with wine as an anesthetic.

PUPILS SHOULD LOOK AND LISTEN FOR:

- The close relation between Egyptian medicine, religion and magic.
- The papyri containing formulas, prescriptions, prayers.
- How paleopathology reveals diseases of the ancients.
- Drugs and treatments used in ancient Egypt.
- The Code of Hammurabi.
- What was thought to be the cause of diseases in Mesopotamia, and how they were diagnosed.

- The practice of trephining; how it probably got to Peru, and why it was necessary.
- Peruvian medicinal plants.
- The magic and symbolism and ritual of the primitive shaman.
- The Mountain Chant ritual of the Navahos.
- Temples of the cult of Aesculapius and the experience of "incubation."
- Votive offerings (healed parts of the patient's body modeled of terra cotta) in the temple.
- The advanced state of Indian medicine and surgery as shown in the collection of Súsruta.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

After the paintings have been viewed and the above points noted, discuss with the class:

1. The difference between primitive medicine and that of the Egyptians and Greeks. (Beyond the psychotherapeutic values of magic and religion, the Egyptians and Greeks made solid advances in observation and rational treatment.)

2. Why does the Code of Hammurabi seem strikingly modern? (Its sliding fee schedule based on the social status of the patient.) The influence of this code spread to the Jewish philosophy - "an eye for an eye, a tooth for a tooth."

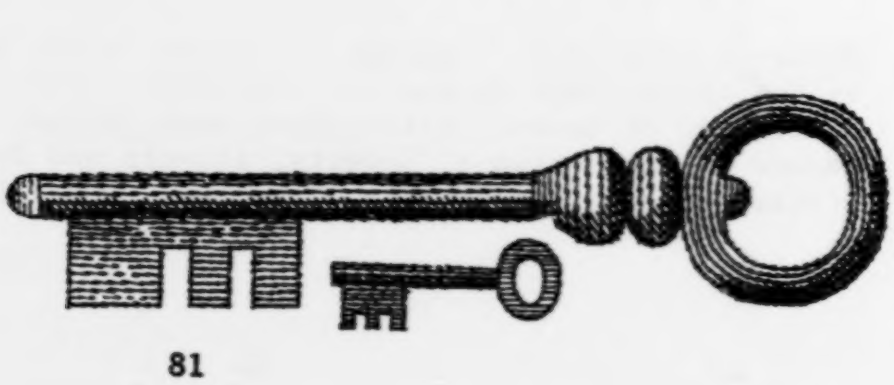
3. Why does primitive medicine differ so radically from ours, yet have similar aspects? (Primitive logic is different. Disease is thought to be caused by supernatural powers and must be dealt with by magic. Much primitive medicine is psychotherapeutic. Modern medicine also utilizes this approach.)

4. The modern health spa aspect of the temples of Aesculapius, the symbolism of the serpent and the names of his children.

5. Why was expert plastic surgery needed in India? (Because of the practice of mutilation as punishment.)

6. The similarity of Greek and Indian medical systems. (The doctrine of humors, three stages of fevers, case histories.)

7. Why Greek medicine had greater influence on the world. (Greeks developed medicine through a completely secular approach to growing science.)



**CULTURAL ITEM:** "A HISTORY OF MEDICINE IN PICTURES" (Paintings)
(Set 2) 6 colored lithographed paintings by
Robert Thom. Parke Davis and Company

**CURRICULUM AREA:** Science - Biology
Evolution of Medicine from Magic to Science.

**PURPOSES:**

To help students realize how medicine developed from a magico-religious practice toward a scientific profession.

**SYNOPSIS:**

The second series of pictures illustrates the importance of Hippocrates, Galen, Paracelsus and Vesalius in changing medicine from a magico-religious practice to a scientific profession, and the beginnings of the hospital.

1. Hippocrates: Medicine Becomes a Science: Greeks early changed the magico-religious practice of medicine to a scientific (but frequently inaccurate) profession. Best known of its pseudo-scientific theories was the humoral theory. The human body had to maintain a balance of its four humors: blood, yellow bile, black bile, and phlegm. Hippocrates, father of medicine, changed its practice to an art, science and profession. His name has come to represent the beauty, value and dignity of medicine.
   The Picture: Hippocrates is seen palpating a patient.

2. Galen: 45 Generations of Influence Galen's writings and teachings dominated medicine for 1500 years. He studied anatomy, philosophy and medicine, gained a reputation for shrewd diagnosis, and understood psychosomatic elements of illness. He was extremely interested in hygiene and preventive medicine. His dissections cleared up basic anatomic problems. He gave the world a synthesis of medical thought and knowledge solid enough to last for centuries.
   The Picture: Galen is seen in a Roman home applying cupping, a form of treatment he advocated.

3. Rhazes and Arabic Medicine: The Arabs embraced Greek medicine and added their own discoveries. When knowledge of medicine in Europe died down in the Dark Ages, it was brought back again by translations of Arab works. Rhazes wrote 237 medical books, including an encyclopedia, describing diseases and their cures. Other Arabs, Avicenna and Maimonides, were brilliant lights of medieval medicine.
   The Picture: Rhazes, first to describe measles and smallpox and report pupillary reaction to light, examines a patient.

4. Medieval Hospitals: Impetus was given to the development of hospitals by the plagues and by wounded Crusaders. One of the oldest of these is Hotel Dieu de Beaune, established when famine, pestilence and warfare caused so many cases of poverty, illness and destitution, that small cities could no longer cope with them. Hotel Dieu gradually changed

from a hostel for the poor and aged to a modern hospital.
The Picture: The Great Room of the Poor is the world's oldest edifice in continuous use as a hospital.

5. Paracelsus: Stormy Petrel of Medicine: Paracelsus, first to realize the necessity for cleanliness in preventing infection, scientific dosage, and use of pure chemicals for specific diseases, turned medicine away from Galen.
   The Picture: Paracelsus, most controversial figure in medical history, in his "chemical kitchen."

6. Vesalius and the Anatomy of Man: Vesalius raised the study of human anatomy to a science based on observation. His demonstrated anatomy lectures, charts and books revealed Galen's errors. He is called the first man of modern science.
   The Picture: Vesalius conducts an anatomy demonstration.

PUPILS SHOULD LOOK AND LISTEN FOR:

- The Greek humoral theory and remaining evidences of it in our language. (The words sanguine, phlegmatic, melancholic and bilious, bad humour)
- The Hippocratic oath and its significance.
- The synthesis of medical thought given to the world by Galen, his lasting influence.
- How the Arabs brought knowledge of medicine to Europe.
- When and why hospitals first began, the oldest hospitals, their changing character.
- Paracelsus' rebellion against medieval medicine and his contributions to chemotherapy.
- Vesalius' contributions to anatomy and changing medical thought.

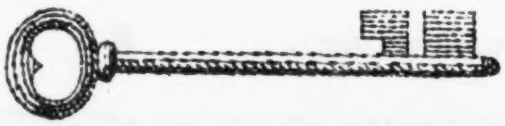
SUGGESTED FOLLOW-UP ACTIVITIES:

Discuss with the class:

1. The import of the Hippocratic oath.
2. The changing role of medicine from magic and dogma toward observation and science.
3. The development of the hospital from a hostel.
4. The development of chemotherapy.

SUGGESTED RELATED ACTIVITIES:

Some students may wish to do research on some aspect or personality in medicine. Others may wish to find paintings of which the subject is related to medicine, such as Rembrandt's "Dr. Culp's Anatomy Lesson."



**CULTURAL ITEM:** "ABOUT TIME" (Film)
Bell Telephone Co.
Part I, 30 minutes, color.

**CURRICULUM AREA:** Science, "Nuclear Energy," Earth Science.
Nature of Time - Ways of Measuring Time.

**PURPOSES:**

To review the history of the study of time.

To explain various means of keeping time.

To show how calendars are set up and why they are inaccurate.

To demonstrate various time "instincts" of living things.

**SYNOPSIS:**

The King of Planet "Q" wants to establish time on his planet, so he comes to Dr. Frank Baxter for advice Dr. Baxter, with the aid of cartoon illustrations and an "EARTHSCOPE," through which he sees the history of the study of time, endeavors to help the King.

The keeping of time is traced from the earliest sun dials to Galileo's pendulum clocks and modern quartz crystal and cesium clocks with maximum errors of one second in three thousand years

Dr. Baxter explains to the King how earth time is based upon the rhythms of nature. He also describes the steps which have been taken to alleviate the inaccuracy of our calendars.

**SUGGESTED PREPARATION OF THE CLASS:**

- To prevent confusion, prepare the students for the film's commercial messages.
- To prepare students for the concepts presented in the film, ask them how they would explain time to someone who knew nothing about it. This may make them aware of the difficulties of describing something usually "taken for granted."
- To foster an appreciation of the importance of time - keeping devices in daily living you might have the class list and explain the operation of time-keeping devices used every day

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- Early methods of telling time.
- Internal "clocks" in nature.
- How Galileo's discovery revolutionized methods of time-keeping.
- Improvement in the accuracy of time-keeping.

**PRESENT MEDIA.**

**SUGGESTED FOLLOW-UP ACTIVITIES:**

To make sure the class has understood the concepts and facts developed in the film, the teacher might discuss:

- How man has used heavenly bodies to keep track of time.
- How internal clocks operate in some plants and animals.
- Why there is always some inaccuracy in pendulum clocks.
- Why it is important that time be measured in infinitesimal units.

## SUGGESTED RELATED ACTIVITIES:

The following activities may stimulate appreciations and provide for deeper insights into concepts related to time:

- The importance of time in music may be stressed by demonstrating a metronome borrowed from the music department. Why is it essential to musicians? How does it work? Explore the idea that musical time is really mathematical: marches are 4/4, waltzes are 3/4. Help them to see that they readily like music with a simple regular beat, but often dislike at first, music with more complicated time patterns they find difficult to follow.
- Lead them to understand that simple beats in music are related to natural bodily rhythms such as the pulse. Therefore, simple rhythms are easily understood and enjoyed. More complicated rhythms, such as those used by some modern composers, require some intellectual effort to enjoy. Once the intellectual effort is made, new fields of enjoyment are opened up to the listener.
- To encourage students to investigate how time is portrayed in the theatre, you might ask them to note various techniques employed in the movies and plays they see, such as a flashback and montage.

## RELATED CREATIVE ACTIVITIES:

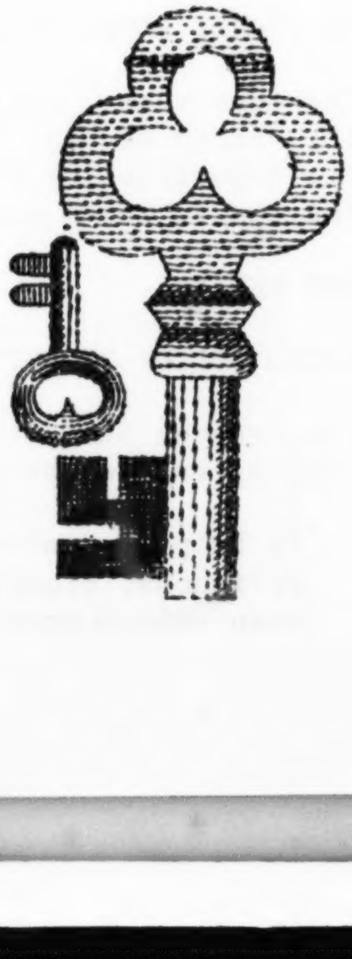
Some students might be interested in working on a science fair project dealing with the "time instinct" of plants or animals.

## RELATED MATERIALS:

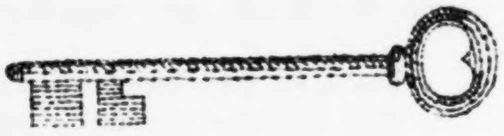
### Films:

"About Time" - Part II
Bell Telephone Co.
30 minutes

"The Romance of Time-keeping"
Modern Talking Picture Service
28 minutes



**CULTURAL ITEM:** "ABOUT TIME" (Film)
Bell Telephone Co.
Part II, 30 minutes, Color.



**CURRICULUM AREA:** Science, "Space Travel," Earth Science.
Time is Relative - Our Feeling for Time is Limited.

**PURPOSES:**

To demonstrate that time is not absolute but relative.

To point out the inadequacy of our senses in appreciating great magnitudes of time.

**SYNOPSIS:**

This is a continuation of Part I. Dr. Baxter uses analogies and other explanations to prove that our feeling of time is limited. For example, our senses cannot comprehend the meaning of the four-and-a-half-billion year history of the Earth, which is briefly reviewed through animated illustrations.

Experiments which prove that time is relative (1887 - Michelson and Morley) are explained. Einstein"s "Relativity" is illustrated by an animated sequence in which an identical twin goes on a space trip and returns much younger than his twin brother.

Finally, Planet Q's King presumably knows enough to start "time" on his planet. The film ends on a note of the mystery of the true nature of time.

**SUGGESTED PREPARATION OF THE CLASS:**

- If Part II is to be used alone, read or explain the synopsis of Part I to the class to orient students for the film's concepts.
- To prevent confusion, prepare students for the film's commercial messages.
- To awaken students to the incomprehensible vastness of time, draw a time line on the chalkboard representing 4.5 billion years. Have the class discover how infinitesimally short man's existence has been by marking off the approximately one-and-a-half-million years of human history.

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- The idea that time is relative depending on the way it is perceived.
- The theory of what time is.
- The importance of time as it exists beyond our familiar everyday concepts.
- The way in which music emphasizes the mysteriousness of time.

**PRESENT MEDIA.**

**SUGGESTED FOLLOW-UP ACTIVITIES:**

1. To broaden student perception and insure understanding of the film's concepts, engage the class in these or similar activities:

   - To help students understand that our perception is based upon our experiences, discuss the difficulty of our perceiving time as "slowing down" when objects move very fast.

2. To emphasize that the topic of "time" is still mostly unknown, ask students to contribute to two lists placed on the blackboard:

   - What we know about time.
   - What remains unknown about time.

3. To relate the new learnings and other knowledge (an excellent means of insuring its good use), explain to students that:

   - The arts exist in space and time.
   - Music is a time art.
   - Painting and sculpture are space arts.
   - Combined arts, such as opera, exist in space and time.

**RELATED CREATIVE ACTIVITIES:**

The teacher could demonstrate the usefulness of analogies in coping with things difficult to perceive by recalling how Dr. Baxter utilized an analogy between the complete history of our planet and a 24-hour day to make it easier for us to appreciate vast spans of time. Some students might wish to make similar comparisons using a week, a month or a year in their analogies.

The writing of science fiction short stories based upon "Peter and Paul," the identical twins who are separated for many years while one is on a space flight, could be encouraged.

The students might enjoy adding "O. Henry" endings to these stories.

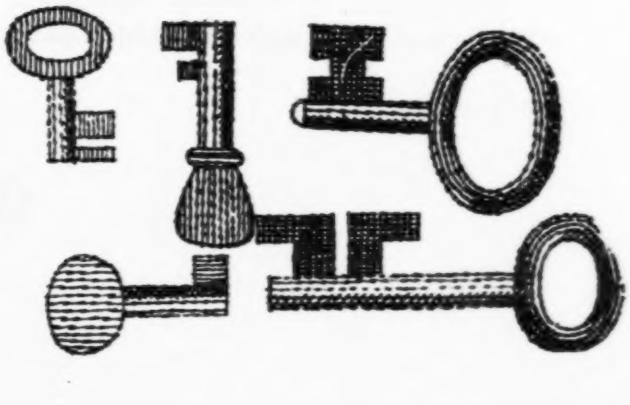
**RELATED MATERIALS:**

Films:

"About Time" - Part I
Bell Telephone Company
30 minutes

"The Romance of Timekeeping"
Modern Talking Picture Service
28 minutes

Paintings in which motion and time are expressed such as Duchamps' "Nude Descending a Staircase."



**CULTURAL ITEM:** "THE ROMANCE OF TIME KEEPING" (Film)
Eterna Watch Company

**CURRICULUM AREA:** Time - The Development of Ways of Measuring Time.

**PURPOSES:**

To acquaint students with ways in which man has kept time in the past.

**SYNOPSIS:**

Ancient Egyptians told time by the lengthening shadow of a stick stuck in the ground. Gradually these evolved into obelisks, which stood for the finger of the God Ra. Aucient Chinese told time by water leaking from one bowl to another. Ancient Romans added gears to these water clocks, and a debate in the Senate was limited to the length of time a bowl of water took to drip away. Slowly burning joss sticks eventually burned a thread which dropped a metal sphere with a loud clang, the ancient Chinese equivalent of an alarm clock. More familiar is the sand glass, which was portable but required too much attention. The concept of hours on the sundial came in the Middle Ages, but dials only told time in the sun. Later, in the 14th Century, clocks with pendulum and gears powered by wound ropes and weights performed in Italy, Switzerland and Germany. Bells rang, men danced, cocks crowed on these ingenious devices, many of which are still working today.

Peter Heinlien of Nuremberg was the first precision mechanic to use a coiled spring to store power making possible the first egg- shaped pocket or table clock. Errors of two hours of more were common on these, and it was necessary to carry a pocket sun dial to check on them. Later, Peter used a pig's bristle to restrain folio motion, which was the forebear of the hairspring of today.

The rest of this film displays in detail the manufacture of precision watches in Switzerland.

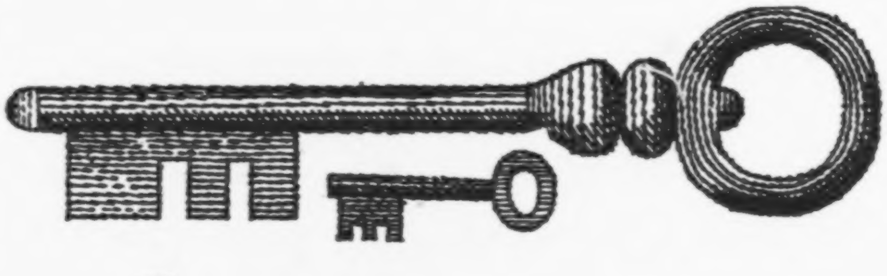
**SUGGESTED PREPARATION OF THE CLASS:**

This film tells its story well and needs no introduction.

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- Ancient Eygptian, Roman and Chinese methods of telling time.
- How clock mechanisms of the Middle Ages worked.
- Peter Heinlien's discoveries (coilspring, hairspring).
- The first portable watches.
- Methods of making and checking precision watches.

**PRESENT MEDIA.**



SUGGESTED FOLLOW-UP ACTIVITIES:

To impress students with the necessity for care and precision in scientific and mechanical work, discuss:

- How a watch works.
- Qualities necessary for making precision instruments.
- Testing procedures (oscillograph and waterproofing, electronic timer).

SUGGESTED RELATED CREATIVE ACTIVITIES:

Some students may wish to do research on ancient time pieces, or make a water, fire or sun clock. Discuss possibility of using solar energy to run the clock.

SUGGESTED RELATED ACTIVITIES:

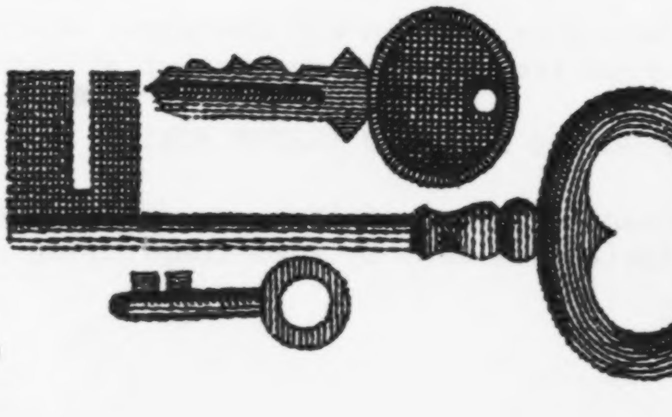
1. Secure Life Nature Library book "The Universe" to show background information on man's early attempts to tell time. Explain the relation of the clock in connection with astronomy:

   One thing that limited medieval astronomers was the elastic concept of time. The day was divided into 12 hours from sun up to sunset thus making winter hours shorter in length than summer hours.

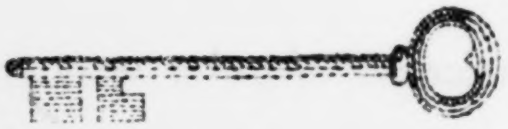
   In 1362 Giovanni de Dondi finished on astronomical clock that not only told time but also recorded the movements of planets with an extraordinarily complicated gear train. A replica of this clock is in the Smithsonian Institution.

2. Help students realize the astronomical nature of time by comparing earth time with time on other planets.

| Planets | Year | Day |
|---|---|---|
| Mercury | 88 days | 88 days |
| Venus | 225 days | unknown |
| Earth | 1 year | 1 day |
| Mars | 1.9 years | 24.6 hours |
| Jupiter | 11.9 years | 10 hours |
| Saturn | 29.7 years | 10.5 hours |
| Uranus | 83.7 years | 10.7 hours |
| Neptune | 166 years | 12.7 hours |
| Pluto | 247.7 years | 6.4 days |
| Sun | ------ | 25-33 days |
| Moon | ------ | 27.3 days |



**CULTURAL ITEM:** "MYSTERY OF TIME" (Film)
40 min., Color, Moody Institute



**CURRICULUM AREA:** Science - Time, Photography
Time Compression, Slowing and "Freezing" through Photography.

**PURPOSES:**

To help free the viewer's mind from the habitual shackles of time by altering the time dimension.

**SYNOPSIS:**

The high-speed camera adjusts time to disclose the unusual beauty in the splash of milk, the cracking of an egg, the take-off of a housefly and the crash of an automobile. The time-lapse camera compresses time to reveal much that occurs too slowly to be perceived. In a few minutes, we witness the events of a three-day vacation, including spectacular sight-seeing, storms, clouds, sunsets, moon and stars. The compression of time provides a great deal of humor in an auto on a freeway, in a football game and on a trip through the Panama Canal. Camera lens and sound adjustments and an imaginary room acceleration make it possible for us to obtain an impression of how time would slow down, size shrink, and mass increase appreciably at speeds approaching that of light. The concluding portion of the film focuses on the vastness and mysteriousness of the universe and affirms the omnipotency, omniscience and omnipresence of God.

**SUGGESTED PREPARATION OF THE CLASS:**

1. To enable students to imagine perceptions they would experience within a different time system, ask them to relate observations they would be able to make if time within the classroom were slowed down sufficiently. Elicit such phenomena as:

- The flickering of all alternating current appliances, due to the electricity's cyclical nature.
- A decrease in the number of heartbeats, pulsebeats and breaths per minute (former system).
- The "writing" of a television picture by electron beams.

2. Ask for observations which would be made within a speeded-up time system. In this case, these observations could be made:

- Plants growing.
- Dust and grime accumulating on furniture.
- Motion which becomes too fast to be observed.

3. Emphasize that in all the above descriptions, the observer would have to be exempted from time alteration or all would appear unchanged.

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- Unusual effects of high-speed photography.
- Disclosures made by time-compressing photography.

- The speeded-up freighter going through Panama Canal locks.
- How experiments with the cyclotron prove aspects of relativity.
- The fact that a car shrinks infinitesimally when it is in motion.
- How light which emanated from the Earth nine years ago (including our images) is now striking Sirius.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

1. Applications of the effects of objects moving at speeds approaching the speed of light can be explored, with an emphasis on possible outcomes of further scientific research into relativity:
   - The slowing of time.
   - The shortening of length.
   - The increase in mass.
2. An examination of the extent to which the film has helped free students from the prison of our time system can be afforded by eliciting and listing on the chalkboard the facts and concepts of time illustrated in the film and working these into a definition of time.

RELATED CREATIVE ACTIVITIES:

1. Encourage students to express their concept of time through the arts. If the means chosen is poetry, you might read a superb example to the class by Longfellow:

   "What is Time? The shadow on the dial, the
   striking of the clock, the running of the sand,
   day and night, summer and winter, months, years,
   centuries - these are but arbitrary and outward signs,
   the measure of time, not time itself.
   Time is the Life of the Soul."

2. Science fiction story-writing by students, involving the mystery of time, might be stimulated by the viewing of the film.

RELATED MATERIALS:

Films:

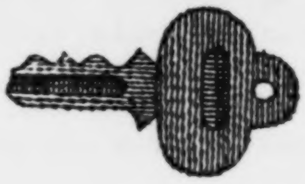
"About Time," two parts, 30 min., Color
Bell Telephone

"Motion and Time" - Color
Sterling Films

Books:

"The Universe and Dr. Einstein" - Lincoln Barnett
"Design of the Universe" - Fritz Kahr
"The ABC of Relativity" - Bertrand Russell

CULTURAL ITEM: "HOW VAST IS SPACE?" (Film)
Atlantic Productions, Inc.
18 minutes, Color.



CURRICULUM AREA: Science-Space, Nuclear Energy.
Atomic Arrangement - Earth Science.
Man's Relationship to Microcosm and Macrocosm.

PURPOSES:

To develop a sense of scale which will permit students to visualize relative size and distance in our universe.

To prepare a foundation for further concepts of space and its meaning and influence on us.

SYNOPSIS:

In the film, a teenage girl is the beginning point for two journeys, one into the macrocosm; the other into the microcosm. These journeys, from the edge of infinity to the nucleus of a sodium atom of a salt crystal, begin with a scale of one to one. Each successive scale is one-tenth of the preceding one. We see, successively, the girl, her home town, the state of California, and the Earth itself. We continue moving in imagination out through the Solar System, the Milky Way, and beyond to other galaxies until, at last, even a galaxy is a pinpoint.

We return to the girl. By magnification of scale, grooves in her skin become visible, and then the skin structure itself, the tissues and cells, blood vessels, sweat glands, a virus. At a magnification of a million, a schematic diagram replaces the enlargement of image. Shading now indicates that the probability is greater that a particle will be found there than in a place that is more lightly shaded. The magnification increases until we see the sodium atom's nucleus at a scale of ten million million to one, at which scale a man would be relatively about the diameter of the Solar System.

SUGGESTED PREPARATION OF THE CLASS:

1. To further develop the concept of space and size, and the meaning of scale, select a scale and demonstrate it. Show the proportion 100:1, for example, by drawing on the chalkboard a square measuring fifty inches and placing a one-half inch object or illustration in the center.

2. To illustrate the vastness of space within atoms, provide some analogies:

- If space were "squeezed out" of atoms until we had matter alone occupying one cubic inch, the cubic inch of matter would weigh 80,000 pounds.
- If an atom were magnified so its nucleus was the size of a baseball, an electron would be about twenty miles away.

3. To orient students to their location in the universe, have them write their return addresses on an imaginary letter to be sent to a pen-pal on a planet in a distant galaxy. The return address could be developed on the chalkboard:

Name
Address
Hemisphere - Western
Planet - Earth

City, State
Zip Code
Country - U.S.A.
Continent - North America
Star - The Sun (Solar System)
Galaxy - The Milky Way
The Universe

4. Thanks to technology, man's environment is constantly enlarging. Discuss how improving transportation, inventions and discoveries, such as the telecope, radar, sonar, electron microscope and others have extended man's powers of sight and hearing inward and outward to areas previously unknown to our limited perceptions.

5. Develop the concept of exponents so students will understand it in the film.

### PUPILS SHOULD LOOK AND LISTEN FOR:

- What exponents are, and how they are used.
- Scales at which color exists.
- Scales within which life is known to exist.
- The size of man as compared with the universe.

### PRESENT MEDIA.

### SUGGESTED FOLLOW-UP ACTIVITIES:

To extend concepts of new frontiers in space and their meaning, use an opaque projector to demonstrate actual magnification and minification of the following pictures:

- Viruses under an electron microscope (found in most science textbooks).
- Patterns in matter revealed by microphotograph.
- Photographs taken from space satellites. Astronaut Gordon Cooper's photos are featured on front and rear covers of NASA's booklet, "Space: the New Frontier."

### SUGGESTED RELATED ACTIVITIES:

Explain that scientists and artists constantly explore and study nature in their own ways. Often both are stimulated by the same inventions and studies. Both scientists and artists have handled space in different ways at different times. Space is an inherent and vital part of painting, sculpture and architecture. Sculpture is design in space. Architecture is enclosed space. Dancing is design and movement in space. Play the sound track of the film to show how music can indicate mystery and vastness.

To help students understand space as used by the artists, display Metropolitan Seminar Prints:

Virgin and Child Enthroned - Portfolio 8, Print 9.

Help students realize the flat gold background pushes the figures right out to us, where we cannot avoid being conscious of them. There is little space here.

Maids of Honor - Portfolio 2, Print 19.

Velasquez has indicated enormous amounts of space in this picture. It goes out through the back of the picture and out through the front as all eyes are focused on the king and queen, out of the painting reflected in the mirror. We are aware of the space out the window to the right and on the canvas to the left. View print in mirror for greater depth.

Island of the Dead - Portfolio 12, Print 139.

Many surrealist artists use effects of vast space to give the feeling of emptiness, loneliness and the dream world. Space in painting is provided by means of linear or aerial perspective. (See insight sheets on Space and Perspective.)

## RELATED CREATIVE ACTIVITIES:

Science depends upon artists' conceptions to visualize objects too large or too small to be seen. Students might draw or paint their conceptions of some "unseeables" they have learned about:

. Arrangement of protons and neutrons in the nucleus.
. The known universe as a tiny part of an infinitely more vast universe.

## RELATED MATERIALS:

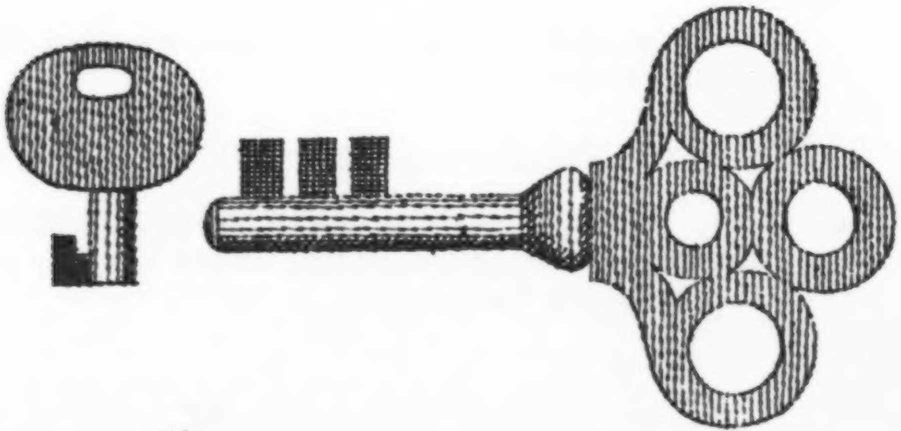
### Film:

"About Time" - Parts I and II.
Bell Telephone

### Recording:

What is the Milky Way?
(Space Songs, Science Materials Center)

**Note**: See CUE lessons on "Physics and Painting" and "Art and Motion" for further treatment of space.



CULTURAL ITEM: "PHYSICS AND PAINTING"
National Gallery Paintings and Prints

Note: A colored slide set and manual are available for this lesson, or reproductions of the paintings may be used to illustrate points made.

CURRICULUM AREA: Science - How Scientific Thought Affects Art.
Physics - form, space, density, weight, movement, time, light, color.

PURPOSES:

To show ideas held at different periods about the physical construction and behavior of matter.

To help students view paintings with more comprehension and to see how they reflect the scientific thought of their day.

SYNOPSIS:

Certain basic changes in painting can be explained best through the parallel of physics and painting. These involve conceptions of volume, density, motion, time, space, light and color. Conversely a study of the history of art can make us more aware of ways in which previous scientists have rationalized the world we live in.

Although this lesson does not try to show any direct effect of physics on art, comparisons between the two fields help explain historical changes of style in paintings.

The painter uses color, line, form, shape and other elements to arouse ideas, moods and feelings in the observer. As the physical ideas of the world enlarge, the painter tries to represent them in his work. He uses art elements to suggest space and time.

SUGGESTED PREPARATION OF THE CLASS:

Slide 1 - Display The Calling of the Apostles Peter and Andrew, Duccio di Buoninsegna (1308-11). Notice how the entire picture seems a flat plane, a shallow stage with figures spread across the front. The gold sky symbolizes the fiery heavens which medieval men thought enclosed the universe.

Slide 2 - Display Tintoretto's Christ at the Sea of Galilee (about 1560). By this time, Copernicus had published his new ideas of the universe. Notice in this painting the spacious sky. Earth and water occupy physical space. Figures gesture in depth. Clearly, concepts of the world had now changed radically.

Observe National Gallery paintings to see how changing ideas of the physical world are reflected in paintings in the areas of forms and space, density and weight, movement and time, light and color.

Slide 3 - Display Fludd's Structure of the Macrocosm, which shows earth at the center, surrounded by water, air and fire. Moon and planets were thought to be embedded in transparent revolving spheres; a circle of fixed stars surrounds the planets and the outermost layer is fire. Fludd shows us how medieval man imagined his world.

Slide 4 - Display Madonna and Child by Margaritone. This sacred figure exists in the eternal reality. The artist used a flat gold plane as symbolic of heaven. The flatness of the image makes it unreal and gives it a timeless character. Philosophically, this heaven was more "real" to medieval men than life itself; it was the ultimate reality.

Slide 5 - Display Botticelli's Adoration of the Magi (Renaissance 1640). New knowledge of perspective enabled artists to divide space into three parts - foreground, middleground and background - occupied by solid forms. Space, no longer a mystery, was reduced to orderly mathematical laws. (Actually, since we have two eyes in constant motion we do not see according to perspective principles.)

Slides 6-7-8 - Through the work of Copernicus, Galileo, Kepler and Newton, man began to grasp the idea of space as extending infinitely and existing eternally.

Slide 9 - Display Hobbema's A View on a High Road (1665). There are no sharp breaks in space here. The recession from foreground to far distance is smooth and the forms are united within it. Space is now continuous, and so it becomes a unifying element in this painting.

Slide 10 - Display Braque's Still Life LeJour. In modern physics, however, the notion of an object as a form extended in space, and persistent in time, is no longer really meaningful. A substance is now a series of events, connected in an unknown or casual way, taking place in space-time. This concept of science is paralleled in the Cubist's method of painting. In this still life, the artist has broken the objects into broad planes of color and reassembled these into a pattern that merely recalls the original objects. These planes, then, represent a sequence of distinct experiences which are joined in the observers mind.

Slide 11 - Display Cezanne's House on a Hill (1906). Here objects do not exist in a unified space at one moment of time. They are the sum of the different spatial experiences Cezanne felt as he looked at different parts of each thing and placed it on canvas. Because he looked at each part at a different time, he combined the dimension of time with each spatial experience, and did not force his many observations into the conventional unified perspective view.

## DENSITY AND WEIGHT

Slide 12 - Display Byzantine School Enthroned Madonna and Child. As concepts of space changed, so did concepts of density and weight of matter. In sacred images in medieval times, a weightless, "bodiless" look was striven for to indicate a heavenly quality enabling the subject to hover in the air or heaven.

Slide 13-14 - Display Raphael's Alba Madonna (1509). When Copernicus removed the earth from the heart of creation, notions about gravity had to be revised. Weight was thought of as a yearning in matter to reunite with the perfect spherical shape (earth).

Slide 15 - Display El Greco's Virgin With Saints. Mannerist painters reverted to the medieval style, with figures floating weightlessly in Heaven.

Slide 16 - Display Jan Steen's Dancing Couple (1663). The Baroque period (1600-1700) was the time of Descartes, Huygens, Gilbert, Kepler and Newton, whose theory of gravity led artists to portray figures and objects as if they were heavy.

Slide 17 - The work of Roentgen, Rutherford and Einstein led to the idea that mass was equivalent to energy. Matter, it seems, may be composed of energy and man's common experience of density and weight appears to be only a construct, a figment of the mind.

Slide 18 - Display Monet's Palazzo de Mula. In the 1870's, French Impressionists reflected this idea by disintegrating solid forms in their pictures by using small strokes of painting and "atomizing" their subjects into hundreds of shimmering touches.

Slide 19 - Display Picasso's Girl with Mandolin. Cubism (1909) is a style of painting which illustrates the penetrability of matter, since space is shown breaking through solid forms. The planes of the girl seem suspended in space, as if balanced between electrical attraction and repulsion.

## MOVEMENT AND TIME

As ideas of space and weight changed, so did ideas of space and time.

Slide 20 - Display St. John the Evangelist by Master of St. Francis (1270). Aristotle thought the heavens moved around the earth. Since motion was not thought essential to being, the artist portrays this figure in a static pose which gives it a quality of timelessness.

Slide 21 - Display Tiepolo's Apollo Pursuing Daphne. In the 17th Century, Galileo found motion to be a natural condition of matter. By late Baroque times, figures had to contain a suggestion of motion in order to be credible. From the dynamic movement of these figures comes a new representation of time, of action within a fleeting moment.

Slide 22 - Display Duccio's Nativity. On the other hand, in the Middle Ages sacred events existed in eternity, rather than in a specific time in the past. There was nothing incongrous, then, in a painter's including episodes in a single picture which happened at different times. In this picture, the Christ child is shown twice, at two different times; the annunciation to the shepherds is also shown.

Slide 23 - Display Georgione's Adoration of the Shepherds. In contrast, Renaissance painters demanded that a picture resemble a view through a window and include only what could be seen at a given moment. This Renaissance idea of showing only one instant of time has been followed till the 20th Century.

Slide 24 - Display Picasso's Family of Saltembanques. When recent astrophysicists realized that light from a distant star took many years to reach the earth, the conception of an actual present, an absolute now, had to be discarded. What the observer witnesses is really a succession of "seen-nows." Such experiences relate to the concept of space-time, in which time becomes an added dimension of an experienced object. This idea establishes new possibilities for defining reality.

This picture explores the reality of space-time. Notice we are on eye level with the feet of the Harlequin at left, yet the next moment we are looking sharply down on the feet of the two boys in the center; finally we seem to look at the seated girl from her own level. Our attention has taken time to move through space and make these observations. The concept of space-time may have liberated Picasso from the convention of perspective. By using several different views observed at different times, Picasso incorporated time as a dimension of each object he painted. Later he applied different view points to single objects, and so expressed reality in terms of space time.

## LIGHT AND COLOR

Light and color in a painting have been influenced by the state of physical science and thought of the times.

Slide 25 - Display Chalice of the Abbot Suger (1140). In the Middle Ages, there was a sense of sacred mystery about light. St. John said "God is light" and in the Middle Ages men felt that it was too holy to be studied. Light still remains mysterious even to the modern physicist. In the Middle Ages, light was symbolized in the brightly glowing colors of mosaics, stained glass, or in gold and jewels as in this chalice used in celebrating the mass.

Slide 26 - Display The Adoration of the Magi, Angelico and Lippi. The Renaissance artist analyzed the effect of light and shade on an object in simple planes - one side light, the other darker. In this painting, none of the forms casts a shadow. This approach to light effects is an intellectualized one, reflecting the analytical minds of the Renaissance.

Slide 27 - Display Van Eyck's Annunciation (1425). Here we see a minute examination of nature, a more scientific approach to the character of light. Notice the spectrum colors (which had obviously been scientifically observed), on the angel's wing.

Slide 28 - Display Vermeer's Woman Weighing Gold (1657). Newton thought light was composed of tiny vibrating particles of matter. In this painting, light seems almost tangible as it creeps across the wall and falls on figure and objects to accent their varied textures and solid forms.

Slide 29 - Display Rembrandt's The Mill. Kepler thought color was light buried in substance, and that matter's density or darkness caused difference of color. This idea of light emanating from substance parallels the deep coloring of Rembrandt's Mill. Actually, we see color on an object because it absorbs all but certain rays from the available light; a red object subtracts all rays from daylight except red rays.

Slide 30 - Display Monet's Rouen Cathedral. From Renaissance times, Western painters used color to imitate light. Monet's Impressionism culminated this trend by emphasizing light almost to the exclusion of form. Myriads of colored strokes were meant to mingle in the eye to give a shimmering effect. This type of painting was a direct outgrowth of scientific experiments with color vision at this time.

Slide 31 - Display Gauguin's Fatata te Miti. Gauguin uses areas of flat color to symbolize light. This practice of substituting color for light recalls the increased awareness of their physical interdependence in modern physicists' minds.

Slide 32 - Display Picasso's The Lovers. Modern painters prefer brilliant spectral hues. Picasso uses these not to imitate light but to achieve a luminous color harmony. Complementary colors - green and orange, yellow and violet and blue - surround the white of the girl's blouse, reminding us that white light results from the fusion of such colored lights.

## SUGGESTED FOLLOW-UP ACTIVITIES:

To further student understanding of how changing ideas of the physical world are reflected in painting:

- Show the following CUE films and use related lessons:

  Color (Harvey White Lecture Series No. 12)
  Sense Perception, Perception
  About Time
  Sterling film - Space and Time - for understandings of space-time

- Perform experiments with the CUE Kit optical and color illusions to explain ideas of perspective and color.
- View Metropolitan Seminars and National Gallery prints to find varying representations of space.
- Have students prepare an exhibit to illustrate to the student body and community how changing scientific ideas of the universe are related to changing representations of the physical world in art.
- Learn how scientific color developments were the result of the works of a poet, painter, a physician, a philosopher, mathematicians as well as physicists and chemists.
- Assist students to understand that all knowledge is related; that the work of artists affects the work of scientists and that conversely the work of the industry and science affect the work of the artist.

(See Page 91 for Related Materials)

CULTURAL ITEM: "ATOMIC ENERGY" (Film)
10 min, B & W

"STRANGE CASE OF THE COSMIC RAYS"
58 min., Color, Bell Telephone Company.

CURRICULUM AREA: Physics (Space in Painting)
**How Scientific Thought is Expressed in the Arts.**

PURPOSES OF FILMS:

To assist students to understand atomic energy and that the atom is mostly empty space.

PURPOSES OF THIS LESSON:

To enable students to see the relationship between science and art.

SYNOPSIS:

"Atomic Energy" graphically explains nuclear fission. "The Strange Case of the Cosmic Rays" shows and explains Rutherford's experiments which proved that the atom was a miniature solar system consisting of a small nucleus circled by whirling electrons, and was actually mostly empty space. Cloud chamber experiments which trace the path of subatomic particles are shown.

(Note: These films provide an excellent background on matter as energy for the presentation of the following materials which attempt to show the relationship of contemporary art and science. It is not the purpose of the guide to teach science, therefore no lesson plans are given for the films which lie within the range of pure science.)

SUGGESTED PREPARATION OF THE CLASS:

Show the two films listed above and be sure students understand:

- Matter as energy.
- Nuclear fission.
- The empty space in the atom.
- What cloud chamber tracks are.

Explain to the class:

Although many of us tend to think of the artist as a person far removed from everyday concerns, in actuality most artists are highly influenced by the same problems and thought as scientists are.

Secure and Display: Metropolitan Seminar Prints

Portfolio 2, Print 15 - Braque's "Musical Forms"
Portfolio 4, Print 38,40 - Picasso - "The Studio", Les Demoiselles d' Avignon"

Portfolio 4, Print 44 - Kandinsky's "Black Lines"
Portfolio 7, Print 84 - Seurat, "Sunday Afternoon On the Island of La Grand Jatte"
Portfolio 11, Print 121- Executions of the Third of May

Prints of work of Jackson Pollack, Miro and Calder.
(Secure the assistance of the art teacher if necessary)

To prepare for showing the relationship of science and art, explain: All fields of intellectual endeavor today show the influence of the discoveries, theories and conceptions of modern science. One of the most basic influences is the theory of atomic matter.

The years from 1850 to 1870 saw the development and clarification of general laws and principles drawn from previous work of scientists. The principle of the conservation of matter, the law of dissipation of energy. Dalton's atomic theory, the theory of evolution - all achieved acceptance. These new theories affected artists and writers who turned to "realism" - a scientific method of documentation resulting in works like "Madame Bovary" and Daumier's and Goya's art of social protest. (Portfolio 11, Print 121)

These were changes in subject matter only. The first art works to change their structural elements were those of the Impressionists who painted in little dots and dabs. (Print 84) It was at this time that Dalton's atomic theory received recognition, and the scientific world recognized that the universe was composed of atoms. It seems more than coincidence that painters of the time should compose their canvases of tiny dots and dabs. They were trying to catch light in their paintings, but they did produce paintings which evoked the image of a world made of tiny atoms.

The Neo-Impressionists Seurat and Signac devoted themselves to research in optics and color theory. Many people criticized these scientific artists and said they had gotten out of touch with their instincts, but science continued to fire artists' imagination.

Becquerel, and later the Curies, discovered that uraniuim, radium and certain other minerals emitted invisible rays which could move through space and penetrate various materials. Experiments with alpha and beta and gamma rays led to the conclusion that they were particles of some kind shooting through space.

It was discovered that radiation of this sort ultimately caused the element radium to transmute itself in a series of stages to the element lead. To transform an element is to transform its components and its atoms. Consequently physicists concluded the atom was solid but composed of sub-atomic parts.

In 1911, Rutherford published his findings that the atom was constituted on a solar system basis; tiny electrons moving about a nucleus as planets revolve about the sun, with empty spaces between the elements proportionately as huge as the empty spaces in the solar system. The concept of this tremendous void in the atom is reflected in artistic thought. (Refer to cloud chamber experiment in film.)

Picasso and Braque had been painting angular planes which suggested solid sculptural cubes partially imbedded in the canvas. In 1909, Picasso's (Print 40) "Nude," the facets of the surface begin to slip, opening up complex hollows and spaces within the subject. Later his paintings, though still recognizable as familiar solids , were represented as largely composed of empty space. The realization that the atom was mostly space caused the Russian artist Kandinsky (Print 44) to begin to doubt the necessity for a subject in painting. He felt that the communication power of lines, shapes and colors was, like music, so great that it did not need subject, and he became the father of non-objective painting in 1912.

In 1913, Bocconi, Italian sculptor, said "The circumscribed lines of the ordinary statue should be abolished. The figure must be opened up and fused in space." Older sculpture was created in terms of solids; the new departure was to create in terms of space. He and other constructivist sculptors carried out their work in terms of space.

Further discovery by Schrodenger, Heisenberg, Derac and Bohr reduced matter to the concept of energy. According to Einstein, the only meaning of matter is a region in the space-time continuum where paths through space are curved. The further science probes into the atomic world, the more obscure and shadowy does objective reality seem, the less material and tangible does nature appear to be .

Consequently, painters such as Miro, Gorky, Baziotes, Stamos, Rothko and others exhibit an extreme state of suspension in their work. Even in sculpture such as Calder's mobiles, this is evident. The only certainty left to man is that in this universe there exists some kind of mysterious activity and an even more mysterious order.

In contrast to those who float and contemplate, others resort to action searching the void: de Kooning, Pollock, Tomlin. Their paintings represent nothing, yet suggest action. If you will observe the track of alpha rays or other sub-atomic particles in a cloud chamber, as shown in the film "Strange Case of the Cosmic Rays," you will find the same daring quality, the same intricacy of movement and surface confusion, and the same underlying suggestion of pattern and organization. It is not suggested the paintings are imitations of cloud chamber tracks. It is, however, important to remember that the artist, like the scientist, is trying to find order in his shattered world. Whether the scientist affects the artist, or the other way round, makes little difference. They share a mutual problem and each approaches it in his own way. The truth may be that forces common to the age, and still too close for precise identification, influenced scientist and artist alike to conceptions of the universe which have a startling correspondence.

Art has become abstract as the world itself has become abstract. (Print 38) Today nothing is left of matter. Objects and people are mere ghosts of their former selves. All that is left is energy and void. The artist takes these concepts into mind when he paints. What is still known as realism in painting is actually an escape from reality.

Artists, like scientists, are trying to find the hidden order and pattern of this new and ominous world - one with imagination and intuition, the other with measurements and mathematics.

Showing these relationships stimulates student imagination, an important adjunct to scientific skills, and increases his opportunity for widened interest and pleasure.

SUGGESTED RELATED ACTIVITIES:

- Ask students to look for various renditions of motion and space in paintings exhibited in the school and elsewhere.

- Secure exhibit of stroboscopic photography for study.

- Explain that musicians too are concerned with nuclear energy:

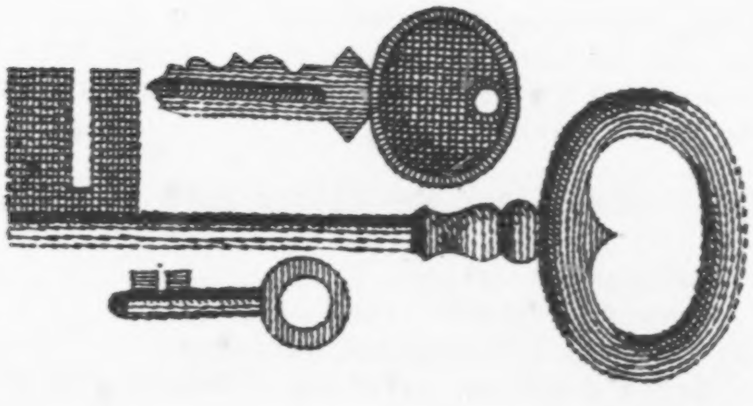
  We live with "the bomb" in an "Age of Anxiety," the title of a musical work by Leonard Bernstein. How does this artist express this anxiety?----

  Dissonance!!!

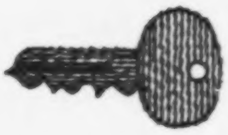
SUGGESTED RELATED CREATIVE ACTIVITIES:

- Have students make photograms to suggest motion.

- Secure and display prints of painting by Seurat, Picasso, Braque, Kandinsky, Miro, Gorky, Baziotes, Stamos, Rothko, Calder, Pollock.



CULTURAL ITEM: "ART AND MOTION" (Film)
**Encyclopedia Britannica Films**



CURRICULUM AREA: Physics - **Scientific Thought in the Arts.**

(Note: Secure aid of art teacher for a team teaching presentation.)

PURPOSES:

To illustrate to students that man's kinetic art forms have their bases in nature, that the same feelings about forces in nature prompt both artist and scientist to study, observe and discover.

SYNOPSIS:

Movement is basic to our universe. All things are in motion. For millions of years, star formations have moved in space; in years to come, they will continue to move. On earth, the forces of nature are ever moving and changing. The dynamic movement and power of life and nature are all about us, in falling water, rhythmic motions of dancers, exploding fireworks. It is kinetically pleasurable to watch these motions. New discoveries have told us everything is in motion, matter is energy.

Artists have tried to capture this movement and change of nature by concepts of time and space movement to give new dimensions to their work. Illustrations of vision in motion and motion in art are beautifully and sensitively treated in this film, and make a concept which is difficult to explain in words easy to understand.

SUGGESTED PREPARATION OF THE CLASS:

Students should be acquainted with atomic fission, the structure of the atom concept and the idea of matter as energy, as shown and explained in the films "Atomic Energy" and "Strange Case of the Cosmic Rays." They should also be familiar with Newton's laws of motion, centripetal force and escape velocity.

**Since this film is to be used to introduce space-time concepts in art and relate them to science, little introduction is needed except to say that scientific discoveries affect the way artists work - or perhaps new knowledge causes both artist and scientist to explore the same ideas. Discoveries as to the nature of the universe constantly affect man's representations of reality. The artist tries to represent the continuous motion of nature in his work. This film will show us motion in nature, and some ways in which some artists try to express motion as an added dimension to their work.**

**PUPILS SHOULD LOOK AND LISTEN FOR:**

- **Motions in nature.**
- **Powerful dynamic line patterns.**
- **Rhythmic motions and patterns.**
- **Balla's motion painting, reminiscent of stroboscopic photography.**

- Kandinsky's method of showing motion through rhythmic tensions of forms in space.
- Explosive movements of fireworks.
- Patterns of motion of the Calder mobile.
- Abstract motion in space made by scratching designs on motion picture film.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

To help students overcome the feeling that the new art is unintelligible, explain that all of us today are concerned with space and motion. Our government spends billions in research for space exploration, for cars, jets, planes to speed up transportation, Telstar has made world-wide communication almost instantaneous. Motion, speed and space concern not only us but the scientist and artist as well. The artist, as always, tries to interpret the age in which he lives. Old ways of interpreting it with the illusion of space achieved by perspective no longer satisfy him or our age.

To illustrate the evolution of representations of space, display Metropolitan Seminar or National Gallery prints to exhibit how space was interpreted in the past as in:

- Primitive and Byzantine painting - layers above each other - Portfolio 9, Print 97, Madonna and Child.
- Size differences to indicate space - Portfolio 9, Print 98, Madonna Enthroned.
- Parallel vanishing point perspective in Renaissance times - Portfolio 6, Print 61, The Last Supper.
- Spiraling and other types of motion in the Baroque - Velasquez's Maids of Honor, Portfolio 2, Print 18 Prometheus Bound by Rubens.
- Aerial perspective - Portfolio 1, Print 17, Imaginary Landscape by Durrand.
- Sharp and unsharp - Portfolio 4, Print 37, Artist in His Studio by Vermeer.
- Cubist methods - Emphasizes planes and lines, stroboscopic views to suggest motion - Print by Braque, Picasso's paintings, Duchamps' Nude Descending the Staircase.
- Stimultaneous views - Portfolio 4, Print 40 Demoiselles d'Avignon paintings by Gris, Braque, Picasso collages "Still Life With Knife." Help each student to grasp each type of interpretation.

An analysis of contemporary painting helps overcome emotional illiteracy and isolation and lessens the fear that the new art is unintelligible, which robs the individual of the vital pleasures of art. A school's duty is to sensitize students to advanced thought in artistic expression.

SPACE - TIME

Because of new scientific discoveries about matter and the universe, a new space-consciousness emerged much in opposition to the tradition of Renaissance painting that gave the illusion of three dimensional objects in an illusionistic space. The Renaissance painter constructed a scene to be painted from an unchangeable fixed point, but speeding on roads and circling in skies gave modern man new view points.

Photography wiped out the excitement of the illusionistic space of perspective. Painting couldn't withstand the competition of this mechanically perfect rendition of monocular perspectives. Painters then tried for a kinetic concept of spatial - articulation - vision in motion.

Vision in Motion is:

- Seeing while moving.
- Seeing more than one view - seeing, feeling, thinking the whole thing in an instant.
- Comprehending space-time, the new dimension.

The Cubists showed an object from many views on the same canvas.

The abstract artists developed the idea of seeing things in a constantly changing field of mutual relationships. This universal principle of relationships is the clue to changes taking place in science, philosophy, education and our whole civilization.

Another concept beside vision in motion which has influenced art is the discovery that the subconscious is a part of the organic function of the human being. Both concepts are actually different sides of the same problem - space-time. In manipulating, measuring, and experiencing our physical and psychological environment, space-time is an added dimension, a refinement of our tools in grasping our environment and understanding ourselves.

If we peeled an apple and laid it out flat, we would have a two-dimensional space-time diagram epitomizing the essentially three-dimensional journey of the knife blade around the apple.

The arts can give us these space-time experiences when we learn to read and relate the emotional meaning of these expressive fundamentals.

Cezanne freed painting from slavish copying of shadows; he reduced shapes to geometric forms. At times he gave a birds-eye view, so that the viewer could see more. He painted objects in the same painting from different view points as though they were being seen from front, side and back at the same time. His desire to bring objects more truthfully to the spectator led him to choose the most revealing view of each object. The result was a composite view, "distortion" if judged within the convention of the vanishing point central perspective, but in reality it was a vision in motion.

We can say that distortion can connote space-time in addition to its other meaning of exaggerating proportions for emotional effect. Later, Cubists gave composite views of objects showing them from both sides and above in the same painting. Picasso shows both front and side views of figures, as in "Guernica."

From early times, man tried to show motion and space by having the same figures in progressive action, as in Memling's Martyrdon of Christ, where the same figure is seen in many places on the canvas to represent different times. This method is used in comic strips, predecessor of the motion picture. A skywriting plane, time and motion studies, cubism futurism, photomontage, superimposed photographs, stroboscopic exposures and scientific graphs all pave the way for this new type of communication. They are but a beginning in the perfection of visual "manuscripts," which will be read more quickly and more precisely than verbal ones, and will express some things which the word in its nature never can.

People have to be taught to read pictures just as they are taught to read and write. Even a photograph couldn't be read unless one knew how to translate its flat planes into the 3- D scene.

In the future, when more science and technology will be part of daily routine,there will be more need of space-time rendering and their accurate interpretations.

Cubists tried to give this vision in motion view by superimposing various views of one object over the other to achieve a stronger emotional effect on the viewer. They used arbitrary shading and light to bring objects out of the background and by so doing the 3-D objects seemed to be projecting from the canvas or revolving in space.

Later artists did away with illusionistic perspective altogether, by slipping one plane behind another leading the eye back and forth in space.

To appreciate a cubist painting, one should be aware of this space-time concept. It is a pleasurable artistic experience in vision, not necessarily a great moral lesson.

Giacomo Balla in "Speeding Automobile" tried to express the speed and violence of contemporary life. Marcel Duchamps predated stroboscopic photography with his "Nude Descending the Staircase."

The surrealists carried the idea of vision in motion and space-time further by trying to express the world of the personality and mind.

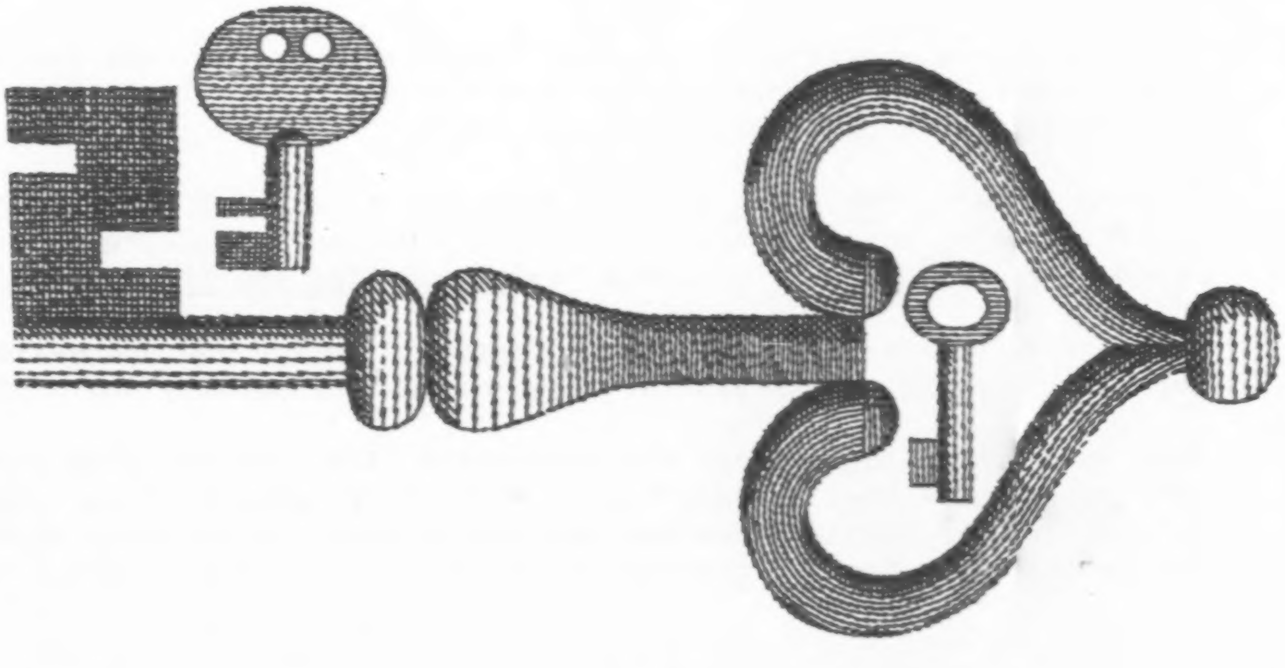
They were protesting against our mechanized life, and the idea that many people have that science could solve every human problem. They felt there were little known and unsolvable problems existing within the human mind. Freud's theories of dreams lent strong credence to to these beliefs. Surrealists tried to paint this dream world. Dali, Tanguy painted this strange world of erie unexplored space. Chagall painted figures freely floating in the air, confirming technological concepts of the transparency of objective forms and showing a disregard of gravity.

Just as it is vital for students to be scientifically literate, it is necessary and pleasurable for them to be aware of what the contemporary artist tries to convey. A study such as this shows the close relationship between science and art, opens new vistas and stimulates the imagination - a quality as vital to scientific research as to art and life itself in this complex ever-changing world.

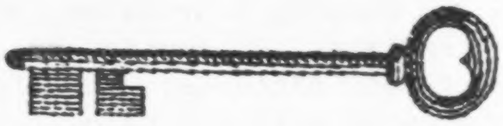
RELATED MATERIALS:

Film:

Surrealism. (Bailey Films)
Cubism. (BaileyFilms)



CULTURAL ITEM: "DRAWINGS AND MODELS OF INVENTIONS OF LEONARDO DA VINCI"
(Slides and booklet)
International Business Machines



CURRICULUM AREA: Mechanics and other fields.

PURPOSES:

To help students gain insight into the relationship between Leonardo da Vinci's artistic and scientific geniuses.

To illustrate applications of scientific principles through drawings and models of inventions.

SYNOPSIS:

Each model is followed by the drawing from which it was constructed:

1,2. Automatic Printing Press. When crank is turned, type and paper on the movable bed are carried under the platen, which is simultaneously pressed down.

3,4. Automatic Drum. Just as in a music box, the placement of pegs in the two drums determines the order and rhythm.

5,6. Steam Gun. Steam was made by water flowing into a barrel kept red hot by live coals. It could shoot a projectile over two miles.

7,8. Scaling Ladder. Similar to modern fire ladders.

9,10. Paddle Wheel Ship. Men turned the cranks.

11,12. Double Hull for a Ship. Inner hull would keep ship afloat if outer one was damaged.

13,14. Ventilator. One story high, turned by water power, sometimes assisted by slaves. Air was drawn into the drum, washed and piped into room.

15,16. Hydraulic Pump. Stream power pumped the water 33 feet up.

17,18. Parachute. Successfully tried out on tower.

19,20. Clock Mechanism. Two independent weights and escapements.

21,22. Flying Machine. Flier steered by windlass, and flapped wings by treadle.

23,24. Double-Armed Crane. Speeded work.

25,26. Odometer. Dials were turned by system of gears.

27,28. Two-Level Bridge. Upper for pedestrians, lower for vehicles.

SUGGESTED PREPARATION OF THE CLASS:

Display a print of the Mona Lisa from IBM booklet to the class and explain: Of course, you all know who painted one of the world's most famous pictures. You also know that da Vinci was a versatile inquisitive genius with a passion for experimentation, whose one desire was to explore and understand the universe. He was also a scientist who studied nature and set it down in drawings. Thus the drawing becomes the instrument for formulating and transmitting knowledge. Leonardo united the spheres of art and science as the complete and perfect method of learning. He didn't feel it was enough to study and state scientific principles. He thought these laws should be represented in their operation and in their tangible appearance.

Point out that job specifications and knowledge demands change so rapidly today that a person who has narrow knowledge of only one area may find himself unable to find new employment should his job become unavailable or automated. Many scientists are musicians or artists.

Discuss the versatily of other Renaissance personalities such as Michelangelo.

**You might read to the class some of the commentary by Canaday regarding the painting or "Leonardo da Vinci, The Scientist," by Heydenreich in the accompanying I.B.M. booklet, is especially useful for background. Heydenreich points out:**

- Leonardo was the first to approach science as an artist.
- To him, the study of nature was a corollary to being a painter.
- The painter's knowledge and ability to represent things is based on what da Vinci called "saper vedere" - to know how to see.
- He believed that the study of nature was the vehicle which would carry him to supreme mastery of artistic design.
- In his "Treatise on Painting" are Leonardo's directions for the pursuit of the arts of painting and drawing, and his discussion in the various fields of practical science necessary to an artist's education: geometry, optics, mechanics, botany, zoology, anatomy, geology and geophysics.

Slides selected from the set may be utilized as a unit on machines or inventions, or may be employed in the development of other topics or subtopics, such as transportation, flight, ships, or communication. The extent to which the scientific principles involved is emphasized depends upon the purpose for the use of the slides. For, example, a unit on transportation would be enhanced by slides 9,10 -Paddle Wheel Ship (comparison with modern screws); 11,12-Double Hull (Flotation); 15,16 - Hydraulic Pump (modern elevators, automobile brakes); 17,18 -Parachute (air drag); 21,22 -Flying Machine (contrast with modern designs); 25,26 - Odometer (comparison with automobile odometer).

### PUPILS SHOULD LOOK AND LISTEN FOR:

- The source of power for each invention.
- Contrast with modern devices.
- The underlying scientific principles being utilized.
- Comparison of drawings with models.

### SUGGESTED FOLLOW-UP ACTIVITIES:

1. A class discussion may be developed centered around the following questions:

   - Do you think da Vinci would have been so versatile if he had confined his learning to one field only?

   - What are the advantages of versatility?

   - What are the disadvantages of overspecialization?

   - Which of da Vinci's ideas were advanced for his time?

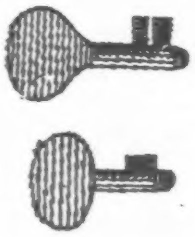
   - What kind of education would produce the creative, inventive people needed to solve the challenges of our modern society?

   - In what ways did da Vinci match the idealized Renaissance Man?

2. Some of the applications of scientific laws may be studied further through demonstrations and discussions:

   - Various uses of Archimedes' principle.
   - How the principle is employed in ship-building.
   - How laws of hydraulics are used in planning city water systems.
   - How Pascal's law is utilized in the modern automobile brake system.
   - Use of the parachute in such modern problems as re-entry.

### SUGGESTED RELATED ACTIVITIES:



1. Study da Vinci drawings in other field, such as:

   - Botany, zoology and anatomy.
   - Geology, geophysics.
   - Architecture.

2. Visit a local art museum to study how versatile Renaissance men took advantage of the new freedom: the freedom of expression.

### SUGGESTED RELATED CREATIVE ACTIVITIES:

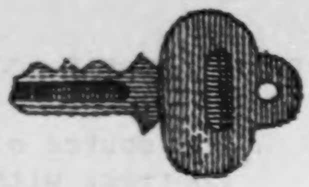
Have students construct in the industrial arts shops some simpler models, such as the Paddle Wheel Ship.

### RELATED MATERIALS:

Films:

Leonardo da Vinci and his Art. (Coronet Films)

CULTURAL ITEM: "DEBT TO THE PAST" (Film)
Moody Institute of Science
21 minutes, Color.



CURRICULUM AREA: Science - Progress is built on knowledge from the past.

PURPOSES:

To generate a sense of personal appreciation for our heritage from the past.

To see our present multiform progress in perspective as part of the continuing stream of history.

SYNOPSIS:

This film touches on many examples of gifts from the past and demonstrates how they form the basis of nearly all that we have or are today.

Through photographic, cartoon and art illustrations, we are shown how three men of three countries and of three ages were responsible for our modern rockets (Hero of 2nd Century Greece, Won Hoo of 15th Century China and Sir Isaac Newton of 17th Century England).

We think of the automobile as recent, but the wheel is essentially the potter's wheel, the levers are the same as those of Archimedes, who boasted that he could move the Earth with a lever which was long enough.

The inclined plane is as useful today as it was to the Egyptians who built pyramids with it. Farming and irrigation methods are basically unchanged, though new machines have been introduced.

Smelters and forges used in ancient times are now employed for the making of steel. Much of modern astronomy stems from the Babylonians, Phoenicians Egyptians and Aztecs. The Atomic Age is exposed as being not new, but 25 centuries old, having begun with Democritus' Atomic Theory. Our money, alphabet, mathematics, printing, governmental system and moral and spiritual values are similarly demonstrated to be derived from past accomplishments.

The last part of the film is a demonstration of what life might be like if one were completely stripped of these gifts. A young man is placed in the wilderness of the high Sierras where he must try to survive without any tool or piece of equipment that may be dated before his own generation. He spends every waking moment with concern for food and shelter.

This film appeals to young people to take advantage of their heritage from the past in the manner of Newton, who attributed his ability "to see farther than others to the fact that he stood on the shoulders of giants." Viewers are reminded that just as there is a past to build upon, there is a debt to the future which they hold, for the world will be better or worse because of those in the present.

3

## SUGGESTED PREPARATION OF THE CLASS:

Students should be made aware of the many contributions of the past to society in general, and to them in particular. This might be accomplished by asking students how their lives would be affected by the absence of antibiotics, electricity, paper, commerce and trade.

The importance of the heritage of the arts can be stressed by activating a discussion of why UNESCO is frantically seeking to save the ancient relics which would be "drowned" by construction of the Aswan High Dam in Egypt.

## PUPILS SHOULD LOOK AND LISTEN FOR:

- How three men of three countries and of three ages made rocketry a reality.
- The significance of the Code of Hammurabi and the Ten Commandments in our moral and spiritual life.
- The history of inventions now taken for granted - the wheel, the lever, the inclined plane, irrigation, smelting and forging.
- The navigational contributions of the Phoenicians.
- The development of hieroglyphic writing and alphabet systems.
- The origins of our systems of commerce, trade, government and law.
- Architectural and other artistic gifts from the past.

## PRESENT MEDIA.

## SUGGESTED FOLLOW-UP ACTIVITIES:

Relating information gained from the film to the immediate surroundings, (the classroom) will foster a deeper sense of indebtedness to the past. You might, for example, encourage discussion of how some of the following are actually gifts from the past:

- The window pole and crank-handle (levers).
- The paper on which students are writing.
- The alphabet being employed in reading and writing.
- Any mathematical symbols in the room.
- Watches, clocks and calendars.
- Artistic displays.
- The educational-governmental system which enables and encourages this discussion to be held.

Follow-up discussion can be achieved by having the students keep a diary of the contributions of past ages which they encounter during the course of a day.

Remind students that one great legacy from the past is their artistic heritage, which contains the quintessence of the wisdom of the ages. By studying and learning to appreciate these arts, we can acquire insight into life and good ways to live it.

## SUGGESTED RELATED ACTIVITIES:

Historical research is vital to the scientist. Students may be motivated toward researching the legacies of the past in areas in which they are talented or interested:

- The development of the instruments of the orchestra.
- The legacy of techniques of painting or sculpture.
- The evolution of the stage since Shakespeare's time. (Use CUE Model)
- The history of graphic arts inventions.
- Research in depth as historical background for a selected science fair project.

## RELATED CREATIVE ACTIVITIES:

While it is impractical to isolate students from gifts of past generations by placing them in the high Sierras, they can employ imagination to record their "adventures" while being deprived of these gifts. The imaginative discourses could be presented in prose or poetry.

## RELATED MATERIALS:

### Films:

"A Light in Nature"
Shell Oil Company

"Man and His Culture"
Encyclopedia Britannica Films

"Our Inheritance from Ancient Greece"
Coronet Films

"About Time. Parts I and II"
Bell Telephone Company

### CUE booklet:

Short Stories of Science and Invention
General Motors
CUE Science Kit

**CULTURAL ITEM:** "A COMMUNICATION PRIMER" (Film)
Ray and Charles Eames
19 min., Color.

**CURRICULUM AREA:** The Communication Process.

### PURPOSES:

To enlarge the student's view of the communication process and to awaken his sensibilities to the myriad of meaningful messages in his environment.

### SYNOPSIS:

This film classic, which is a work of art itself, presents in 18 minutes a comprehensive view of communication which would be difficult to get over to a student in any other way with such economy of time and effort.

It describes the communications process: information source, transmitter, receiver, decoding process, and also describes "noise." It touches on all types of communication: verbal, non-verbal, art, symbols, codes, computers, and the wonders of the human brain, and emphasizes the pervasive force and necessity of effective communication for social cohesion.

### SUGGESTED PREPARATION OF THE CLASS:

To impress students with the importance of communication, discuss the Orson Welles radio drama which mentioned in the newscast manner that our country was invaded by Martians. Relate the panic, confusion and suffering caused by a few broadcast sentences. Or say, "It will be necessary for the class to meet every Saturday from now on to finish our work." Discuss the emotional reaction with the class. Help them realize the power of communication and the social necessity for understanding the communication process.

### PUPILS SHOULD LOOK AND LISTEN FOR:

- The process of communication.
- The special meaning of "noise."
- How "noise" is counteracted.
- Ways in which messages can be conveyed.
- The reasons why some messages are not received.
- Methods of non-verbal communication.
- The place of the human mind in all communications.

### PRESENT MEDIA.

### SUGGESTED FOLLOW-UP ACTIVITIES:

1. Since this film is packed with content and is intended to be thought provoking, discuss thoroughly and make a diagram on the board or overhead projector of the communication process.

2. Using the communication process chart, discuss where it could break down because of "noise." Discuss "noise" (any force which interferes with the message and prevents it from being received - e.g., sound, quality of light, motion,static, picture or other distortion, a worn typewriter ribbon, the nervous conditions of the receiver, other reasons).

3. Discuss redundancy (the extra framework which helps counteract "noise):

    - Use extra words (English is about 50 per cent redundant).
    - Experience and actions, tone, symbols to reenforce meaning.
    - Encourage student discussion of redundancy in their own experience (e.g., a red light which also says "stop;""you are a fine boy, I like you" plus a pat on the shoulder, smile and affectionate glance; the teacher who reads the text to the students).

4. Discuss non-verbal communications:

    - Smoke signals, symbols, burnt offerings. (What is the significance of such ritual?) Other rituals, superstitions such as knocking on wood. Tell the story of the Juggler of Notre Dame, a devout man so poor he could not even buy a votive candle to honor the Virgin. He crept into the monastery chapel and began to juggle as an offering. As the monks peering in the window, shocked at this desecration of a holy place, were about to rush in and drag him away, the Virgin came down and wiped the juggler's sweating brow. The gift was acceptable.
    - Discuss "retablos;" pictures made by peons in Mexico to give thanks for some "miracle of curing."
    - Point out that often words alone cannot communicate the things we want to say. Some of the most wonderful, beautiful, sad or joyful feelings people have are just too big and too complex to put into words. No words seem just right, or all that we can find have wrong meanings attached to them.
    - Music, dancing, pictures, shaped clay or stone sometimes say these feelings better. Men can put simple ideas down in "black and white" and be understood. But the sky at dawn, the beauty of a flower, the feelings of the heart cannot be completely understood in a "black and white" way. Words have no shape or color or texture. They have no rhythm or melody, except as they are used in poetry and song, and then they are no longer only words. There is something beyond words that must be captured to express what man has to say. The arts express these important non-verbal messages.
    - Paintings give such messages. The painters concept is the source of information, the transmitter is his talent and technique, the signal is the painting, the destination is the mind of the receiver. But there is much "noise" which can interfere with messages from artists. The most important sources of this noise lie in the artist's background and the conditions of the receiver. If the message is in Chinese, obviously the receiver cannot pick it up until he learns Chinese.
    - There may be some prejudice or lack of knowledge in the background of the receiver which prevents him from receiving the messages. Some messages such as the conceptions of Galileo, Columbus, and Leonardo Da Vinci, and perhaps of Picasso and other present day artists

may be sent today, but people are not ready to receive them until years or perhaps centuries later.

- Discuss with the class how some symbols die out and lose meaning, except to the anthropologist and archeologist, and how we continue to use such symbols in design unconscious of their original meanings: (e.g., in ancient times, the symbol ▽ came to mean heaven or rain. The symbol △ came to mean earth or fire. Together they meant ✡ heaven and earth. This symbol still is used on German taverns to signify whisky for sale or firewater.) Other symbols have equally interesting connotations and histories.
- Great art has messages of such emotional import that it transcends barriers of time and language and culture.
- To further understanding of the role of observation and perception in decoding messages, discuss ways in which scientists observe phenomena, such as a wave, shoreline and flight of birds to receive messages about conditions in nature far removed from them.
- List on the board with the aid of the class the extensions of man's senses in communication such as radar, both as to sources of information through electron microscope and long range telescope radar; sonar; and number of transmitters of information (radio, TV), other mass media. Bring out that the number of factors now involved makes the problem prodigious. Discuss the role of the computer and the binary system; the need for a "world brain."
- The world has urgent need for the arrangement, filing and retrieving of scientific facts. Creative scientists, who are remaking the future, should have at the tips of their brain fibers the accumulated record of past knowledge in a World Research Data Processing and Retrieval center.
- The concept of bringing together all the knowledge in the world goes back to the Library of Alexandria, and Bacon's Novum Organum. More recently there were the Royal Societies, Index of Scientific Literature and Concilium Bibliographicum. Today we have libraries in Congress, Harvard and Yale. Discuss the role of microfilm, facsimile copying and mechanisms for filing and retrieving. The information of Moscow and Peking should be included in this "World Brain."
- Discuss the role of technology in making such a brain possible.
- Conclude by helping students realize that the human brain is the most wonderful "computing" mechanism created. The electronic brain may be faster at computing but the number of decisions made by the computer is infinitesimal compared to the number of decisions involved in the simplest human act. The human mind equipped with years of training and rare insight is the supreme scientific and artistic tool essential to creative work.

5. Assign students to record for the days the number of verbal messages they received; non-verbal messages they received:

- Messages they could not receive clearly and reasons why.
- Types of "noise" they experienced.
- Where and how the communication system broke down.
- Numbers of times redundancy was used.
- Number of different ways messages were conveyed to them.

- Messages they received about their environment through observation.
- Messages they misinterpreted.
- Messages which could not be conveyed verbally.

6. Divide the class in groups for a buzz session. Let each group report on one of the above topics.

SUGGESTED RELATED ACTIVITIES:

1. Secure and display National Gallery or Metropolitan Seminar Prints. Ask the students to observe and report their feelings about messages received from the paintings. Often they will not be able to put these feelings into words; at times they will have violent reactions for or against a painting. Ask them if it could be because:

   - They like or dislike the subject matter.
   - The painting recalls something good or bad in their past experience.
   - The painting makes them feel a certain emotion.
   - They like or dislike the artist's technique.
   - They may not understand the artist's symbolism.

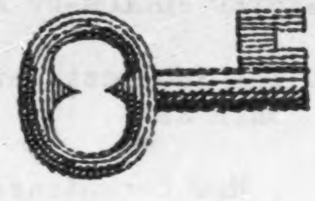
2. Do not condemn these reactions. This is the first step in broadening student perception and sensitivity. They will both grow with exposure.

3. Make a study of symbols both in science and art. CUE'S symbol is ☿ which scientifically stands for the element mercury. Mercury was the fleet winged messenger God of mythology. The mineral mercury was named for him because of its quicksilver qualities. (Experiment with some mercury to see.) ☿ stands also for communications or messages and since CUE stands for communications or messages brought to you, the symbol is represented on the cover of CUE Guides and elsewhere. Study other symbols and non-verbal communication such as pictures and rituals.

SUGGESTED RELATED CREATIVE ACTIVITIES:

Ask each student to choose a message and communicate it both verbally and non-verbally. Which is more efficient and economical of time and effort? Which carries the greater meaning? Help students realize we must utilize many means of communicating to maintain social cohesion and peace. Discuss the role of the arts as means of communicating with other cultures in a shrunken world. Assist students to realize that much of the difficulty and unhappiness in the home, society and world, is caused by faulty communications or inability to communicate. Ask students to recall what they know of modern communication technology. Ask them to take the problem of utilizing this technology to improve communications in general education.

**CULTURAL ITEM:** "COMPUTER SPEECH" (Recording)
Bell Telephone Company
33 1/3 r.p.m.



**CURRICULUM AREA:** Science - Communication, Sound.
The role of Technology and Communication.

**PURPOSES:**

To make the listener aware of the basic components of speech through its analysis and synthesis.

**SYNOPSIS:**

A computer, programmed by punch cards with thirty-four human speech sounds and a set of linguistic and transitional rules, greets the audience in surprisingly human-like fashion. When the computer is fed only the sounds for the sentence, "He saw the cat," however, the result is flat and monotonous. Subsequent provisions of timing and pitch information restore the human quality heard originally in the greeting. The audience is treated to a rendition of "Daisy" sung by one computer while another plays a piano accompaniment. The progress of research in attempting to analyze and duplicate actual speech sounds is demonstrated by computer-reproduced human speech with accents and dialects.

**SUGGESTED PREPARATION OF THE CLASS:**

1. An introduction to computer language can be written on the chalkboard to be deciphered by the class:

   H- EE- S- DH- UH- K- AE-T (He saw the cat.)
   The recording features a computer "speaking" this sentence.

2. To dispel any misconceptions of computer speech, the teacher may point out:

   - Computers do not really talk but produce synthesized speech, according to programmed sounds and linguistic rules.
   - Two sets of instructions are necessary. One part performs the actual sound-making function; the second consists of rules for combining individual speech sounds into connected speech, and for producing control signals that activate the talking machine.
   - The speech comes out of the computer as spots on magnetic tape. The tape is fed to a machine which converts the spots to sounds on tape which can be played on an ordinary tape recorder.

**STUDENTS SHOULD LOOK AND LISTEN FOR:**

- Computer speech with timing or pitch information excluded.
- The famous Hamlet soliloquy, "To be or not to be....," in synthesized speech.
- The electronic "twang" of the singing computer.
- The stylized left hand of the piano-playing computer.
- A synthesized Texas accent.

**PRESENT MEDIA.**

**SUGGESTED FOLLOW-UP ACTIVITIES:**

1. The implications of research into synthesized speech can be discussed such as:

   - New techniques for transmitting speech more efficiently over communication lines.
   - Speaking-typing machines which activate each other thousands of miles apart.
   - Talking machines for people who are unable to speak.

2. Computers have been introduced to the cultural arts. The new art of electronic music, exemplified by Usechevsky's "Concerto for Tape Recorder," is based on the same principles as reconstructed synthesized speech. Portions of sounds are utilized in various tempos and pitches. Computers have composed and performed musical pieces. Some computers have been programmed to write plays. The teacher might present examples to motivate investigation into these cultural innovations.

3. The recording may also prove useful in enabling students to better understand the variables which operate to produce the great speakers and singers of the world. Elicit these variables, perhaps after presenting a recording of a great voice. Vowel and consonant sounds, pitch and timing are aspects previously considered. Resonance, intonation, and the ability to express feelings are others which could be discussed.

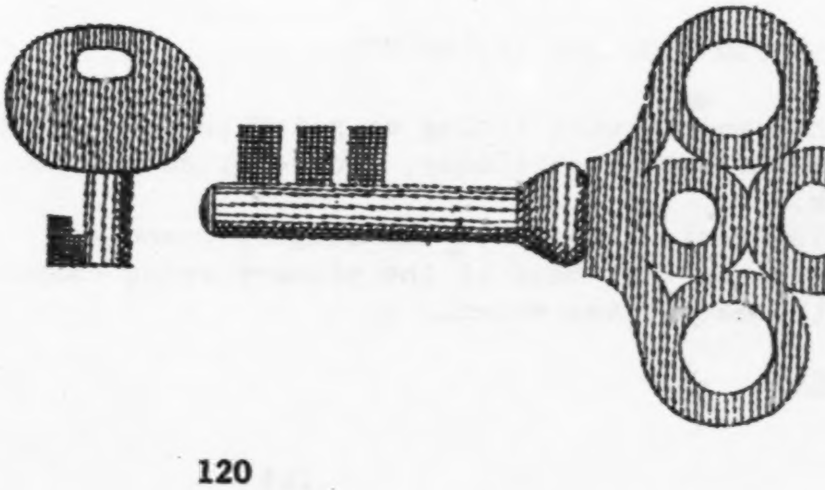
**RELATED MATERIALS:**

**Films:**

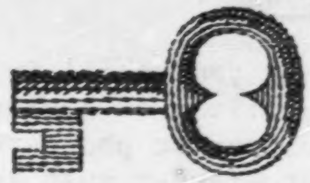
"The Speech Chain" - Bell Telephone Company
"The Thinking Machine"

**Book:**

The Speech Chain - The Physics and Biology of Spoken Language
Denes and Pinson, Bell Telephone Laboratories



CULTURAL ITEM: "THE SIMPLE CAMERA" (A set of filmstrips)
Eastman Kodak



CURRICULUM AREA: Photography - Process and appreciation

PURPOSE OF THE FILMSTRIP SERIES:

To enable students to use the camera and understand the mechanics of photography.

PURPOSE OF THIS LESSON:

To enable students to gain insight into photography as an art, as a way of seeing and communicating.

SYNOPSIS:

This excellent set of filmstrips explains in detail the use of the camera and gives insight into mechanics of photography. Its clarity permits its use as a self-teaching device or it may be used in class or camera club.

SUGGESTED PROCEDURE:

As the class learns the use of the camera through the filmstrips promote understanding of the art of photography by explaining: Unless they are blind many people take seeing for granted - they never really learn to see. Unless you learn to really see well, you miss much joy and opportunity in life. Every appreciation is based on observation. The faculty of creating is never given to us - we must have learned to observe first. Man himself, his insight, his ability to see is the basic to good photography.

In any of the visual arts, painters, poets, writers, observe, remember digest some aspect of life and reform and reshape it in their minds. They then make a play or poem or painting from memory. The photographer cannot use this process. Photography demands keen,quick observation because often the photographer works with the accident. He must learn to recognize just the right moment of something he has never seen before. He must have vision himself and know how to capture the proper moment and present it in such a way that others see in his unique way. To photograph truthfully and effectively is to see beneath the surface,to see the elemental truth of nature. The photographer can only use techniques truly effectively when he has developed his perception. Success in photography therefore depends upon developing a perceptive and selective eye.

Selection

Often it is difficult to see what is about us because life is abounding confusion. One way to really "see" is to use a framing device, made of cardboard. Move this device about till you see something in nature to frame. Select with the frame this something which interests you. Move the frame about until an interesting composition is revealed. Often the simplest objects such as a crumpled piece of paper, when properly framed, reveal interest and beauty. The frame is the aid and the discipline of the photographer.

Timing

As your skill in photography increases learn to select the proper moment, the climax of a situation and "freeze" that event in time. Every situation has a climactic photographic moment. Painters always look for this moment. The photographer must learn to see and use his imagination and select this moment to "freeze." This moment might be one of high excitement such as the knock-out in a prize fight, or one of beautiful composition as in grouping of flowers, or birds or a tender poetic moment that reveals deep feelings or a humorous, laugh provoking situation.

Photography is a language to convey thought and interpretation. Photography provides the opportunity to apply art, to reveal the elemental truth of nature. Reality is transfigured by the imaginative processes and new insight is given to the viewer.

PRESENT MEDIA.

SUGGESTED FOLLOW-UP ACTIVITIES:

1. Have camera club students:

   - Use the framing device to promote "seeing" interesting composition of line, light and shade in ordinary objects.
   - Take photographs showing:
     - Interesting composition showing beauty in ordinary objects.
     - Freezing climactic situations such as a tour de jette or high dive in mid air.
     - Humor or drama in everyday life.

2. Secure and display the Eastman Kodak student photography exhibit for student viewing.

3. Have students view Life Magazine photography critically in the light of new found knowledge.

4. Have an exhibit of student photography.

5. Some students may wish to enter the Eastman Kodak student film making contest.

6. Secure and display CUE exhibit of microphotographs.

SUGGESTED RELATED ACTIVITIES:

1. Assist students to become aware of the importance of photography in science by explaining: If it were not for photography our knowledge of the universe and our world would be relatively slim despite telescopes and mirrors. Discuss the important role of photography in enlarging our knowledge of:

   - The macrocosm (things too big and far away to see).
   - The microcosm (things too small to be seen, microphotography).
   - Things too fast to be seen slowed down by slow motion photography.
   - Things too slow to be observed (time lapse photography).
   - Things too far away in time (old photographs and films).

- Things too far away in space - T-V Telstar - films.
- Things too dangerous to observe closely (wild animals, exploding volcanoes or atom bombs).
- Things in motion (stroboscopic photography).
- Things and relationships we can not see (animation in photography).

2. To promote food for thought about the way in which technology enables us to increase knowledge and power ask: Will some other technological tool further break through our barriers of ignorance to knowledge as yet unknowable to our sense organ equipment?

   Discuss possibilities inherent in:

   - Radio telescopes.
   - Photo electron tubes.
   - Study of the psychology of animals (porpoises).
   - Subelectronics.
   - The science of personality.

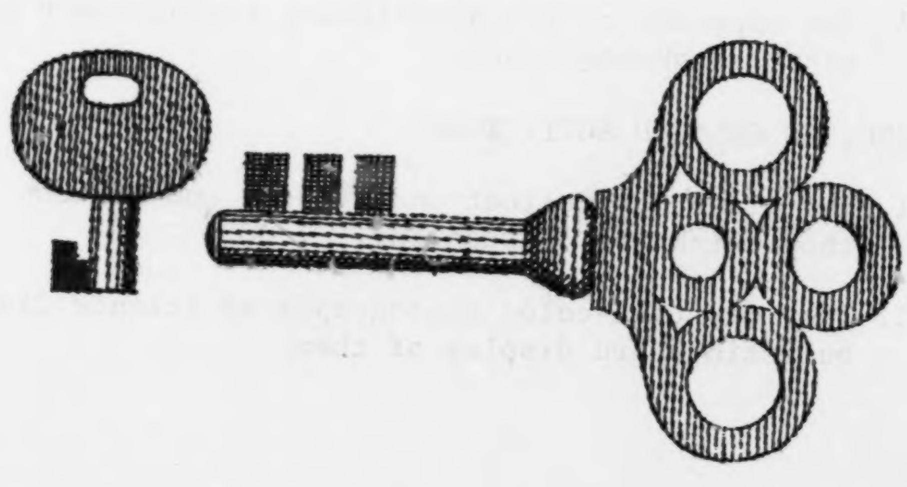
RELATED MATERIALS:

Films:

"The Mystery of Time" (high speed photography) Moody Institute
"Colour of Life" (time lapse) National Film Board of Canada
"The Universe" (telescopic photography) National Film Board of Canada
"World of Little Things" (Microphotography) Moody Institute
"World is Born" (animation in photography)
"Techniques of Photography" Ansel Adams NET Indiana University
"Photography - the Incisive Art" Ansel Adams NET Indiana University
"Color Collage" (color and creative photography) Eastman Kodak

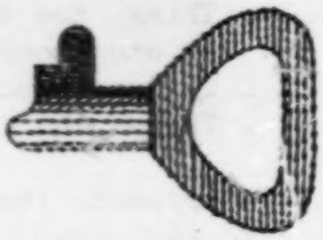
Books:

Family of Man - Alfred Stieglitz
Museum of Modern Art
Paperback



**CULTURAL ITEM:** "COLOR COLLAGE" (Film)
20 min., Color, Eastman Kodak

**CURRICULUM AREA:** Science - Photography
Color and Creativity in Photography



## PURPOSES:

To alert students to the use of color in photography.

To illustrate the difference between advertising and creative photography.

## SYNOPSIS:

This film deals with color in advertising, in art and nature, and points out how the photographer, like the artist and poet, sees nature and truth and beauty as all one. The photography is a visual delight. It also illustrates the use of color in photography.

## SUGGESTED PREPARATION OF THE CLASS:

The delight people have in color is so deep and far back we cannot trace its origin. This film deals with the impact color has on all of us and how it builds its meanings slowly throughout life.

## PUPILS SHOULD LOOK AND LISTEN FOR:

- How a color filter changes the feeling of the same scene.
- The still life arrangements.
- The attention getting factor in color.
- The difference between advertising photography and creative photography.
- According to the film, how man helps to justify his existence.
- What approach to life is unique to man?

## PRESENT MEDIA.

## SUGGESTED FOLLOW-UP ACTIVITIES:

1. Discuss with the class the importance of color in our lives.
2. The approach of the advertising photographer as contrasted to that of the creative photographer.

## SUGGESTED RELATED ACTIVITIES:

1. The class may collect and display and discuss color photograph tearsheets they think are outstanding.
2. They may take color photographs in Science Club or elsewhere and make a bulletin board display of them.

## POETS AND SCIENTISTS

The wonder of the world, the joy of discovery; the desire to share the truths discovered and the wonders uncovered are common to both poets and scientists. In "*Imagination's Other Place*"*, Helen Plotz has gathered together poems about science and mathematics that express the poet's excitement and sometimes his amusement at the imaginative excursions of scientists who, like the poets, themselves, are forever searching the world around them for truth and beauty. Here is a sampling of the poems you will find in this book:

### ONCE A CHILD

It troubled me as once I was,
For I was once a child,
Deciding how an atom fell
And yet the heavens held.

The heavens weighed the most by far,
Yet blue and solid stood
Without a bolt that I could prove;
Would giants understand?

Life set me larger problems,
Some I shall keep to solve
Till algebra is easier
Or simpler proved above.

Then too be comprehended
What sorer puzzled me,
Why heaven did not break away
And tumble blue on me.

*Emily Dickinson***

### from THE CLOUD

I bring fresh showers for the thirsting flowers.
  From the seas and the streams:
I bear light shade for the leaves when laid
  In their noonday dreams.
From my wings are shaken the dews that waken
  The sweet buds every one,
When rocked to rest on their Mother's breast,
  As she dances about the sun.
I wield the flail of the lashing hail,
  And whiten the green plains under,
And then again dissolve it in rain,
  And laugh as I pass in thunder.

*Percy Bysshe Shelley*

### EPITAPH INTENDED FOR SIR ISAAC NEWTON

Nature and Nature's laws lay hid in night:
God said, Let Newton be! and all was light.

*Alexander Pope*

### EUCLID

Old Euclid drew a circle
On a sand-beach long ago,
He bound it and enclosed it
With angles thus and so.
His set of solemn graybeards
Nodded and argued much
Of arc and of circumference,
Diameter and such.
A silent child stood by them
From morning until noon
Because they drew such charming
Round pictures of the moon.

*Vachel Lindsay****

### "I SAW A PEACOCK"

I saw a peacock with a fiery tail
I saw a blazing comet drop down hail
I saw a cloud wrapped with ivy round
I saw an oak creep on along the ground
I saw a pismire swallow up a whale
I saw the sea brim full of ale
I saw a Venice glass five fathoms deep
I saw a well full of men's tears that weep
I saw red eyes all of a flaming fire
I saw a house bigger than the moon and higher
I saw the sunset at twelve o'clock at night
I saw the man that saw this wondrous sight.

*Anonymous*

### RELATIVITY

There was a young lady named Bright,
Who traveled much faster than light.
  She started one day
  In the relative way,
And returned on the previous night.

*Anonymous*

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* Imagination's Other Place, *compiled by Helen Plotz. Published by Thomas Y. Crowell Company. Copyright* 1955 *by Thomas Y. Crowell Company.*

** From Bolts of Melody. New Poems of Emily Dickinson, *edited by Mabel Loomis Todd and Millicent Todd Bingham. Published by Harper and Row. Copyright* 1945 *by Millicent Todd Bingham.*

*** *From* Collected Poems *by Vachel Lindsay. Published by The Macmillan Company. Copyright* 1942 *by The Macmillan Company.*

## List of Producers

Atlantis Productions, Inc.
7976 Sunset Blvd.
Hollywood, Calif.

Bailey Films, Inc.
6509 DeLongpre Ave.
Hollywood, Calif.

Bell Telephone Co.
195 Broadway
New York 7, New York

Coronet Films
65 E. South Water St.
Chicago, Ill.

Walt Disney Productions
16mm Film Division
477 Madison Ave.
New York, N. Y.

Ray & Charles Eames
(Thomas & Paul Cox)
5620 Hollywood Blvd.
Hollywood, Calif.

Encyclopedia Britannica Films
1150 Wilmette Ave.
Wilmette, Ill.

Eterna Watch Co. of America Inc.
677 Fifth Ave.
New York, N. Y.

Film Associates of California
11014 Santa Monica Blvd.
Los Angeles, Calif.

Eastman Kodak Co.
343 State St.
Rochester, N. Y.

Life Time Inc.
9 Rockefeller Plaza
New York, N. Y.

McGraw-Hill Book Co., Inc.
Text-Film Dept.
330 W. 42nd St.
New York, N. Y.

Moody Institute
11428 Santa Monica Blvd.
Los Angeles 25, Calif.

National Gallery of Art
Washington, D. C.

Park Davis & Co.
Sales Dept.
Empire State Bldg.
New York, N. Y.

Shell Oil Co.
Film Library
149-07 Northern Blvd.
Flushing 54, N. Y.

Thorne Films
1229 University Ave.
Boulder, Colo.

THE UNIVERSITY OF THE STATE OF NEW YORK

Regents of the University
with years when terms expire

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| 1968 | Edgar W. Couper, A.B., LL.D., L.H.D., Chancellor | Binghamton |
| 1967 | Thad L. Collum, C.E., Vice-Chancellor | Syracuse |
| 1978 | Alexander J. Allan, Jr., LL.D., Litt.D | Troy |
| 1966 | George L. Hubbell, Jr., A.B., LL.B., LL.D., Litt.D | New York |
| 1973 | Charles W. Millard, Jr., A.B. | Buffalo |
| 1970 | Everett J. Penny, B.C.S., D.C.S. | White Plains |
| 1972 | Carl H. Pforzheimer, Jr., A.B., M.B.A., D.C.S. | New York |
| 1975 | Edward M. M. Warburg, B.S., L.H.D. | New York |
| 1971 | J. Carlton Corwith, B.S. | Water Mill |
| 1969 | Joseph W. McGovern, A.B., LL.B., L.H.D., LL.D. | New York |
| 1965 | Allen D. Marshall, A.B., LL.D. | New York |
| 1977 | Joseph T. King, A.B., LL.B. | New York |
| 1974 | Joseph D. Indelicato, M.D. | Brooklyn |
| 1976 | Mrs. Helen B. Power, A.B. | Rochester |

President of the University and Commissioner of Education
James E. Allen, Jr.

Deputy Commissioner of Education
Ewald B. Nyquist

Associate Commissioner for Elementary, Secondary and Adult Education
Walter Crewson

Associate Commissioner for Cultural Education and Special Services
Hugh M. Flick

Assistant Commissioner for Instructional Services (General Education)
Warren W. Knox

Director, Division of Educational Communications
Lee E. Campion

Chief, Bureau of Secondary Curriculum Development
Gordon E. Van Hooft

Director, Project CUE
Robert M. Brown

Associate Director, Project CUE
Grace Nelson Lacy

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# project CUE

culture understanding enrichment

SCIENCE

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT
ALBANY 1963

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1967 Thad L.Collum, C.E., Vice Chancellor - - - - - - - - Syracuse
1976 Mrs. Caroline Werner Gannett, LL.D., L.H.D., D.H.- - Rochester
1964 Alexander J. Allan, Jr., LL.D., Litt.D.- - - - - - - Troy
1966 George L. Hubbell, Jr., A.B., LL.B., LL.D., Litt.D.- Garden City
1973 Charles W. Millard, Jr., A.B. - - - - - - - - - - - - - Buffalo
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1972 Carl H. Pforzheimer, Jr., A.B., M.B.A., D.C.S. - - - Purchase
1975 Edward M. M. Warburg, B.S., L.H.D. - - - - - - - - - - New York
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Chief, Bureau of Secondary Curriculum Development
Gordon E. Van Hooft

Supervisor of Science Education
Hugh B. Templeton

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Director, Division of Educational Communications
Lee E. Campion

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# project
# CUE

**culture understanding enrichment,** Science

SCIENCE

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT
ALBANY 1963

## FOREWORD

This publication is one of five teacher guides prepared for use in Project CUE, an experimental project designed to increase cultural understanding and enrichment in the educational program by integrating carefully selected audio-visual items into the existing ninth grade curriculum in English, social studies, science, home economics, and industrial arts.

The thirteen schools participating in this experimental project during the 1963-64 school year will receive a basic packet in each of the subjects named above. The teacher guide sheets in this publication have been prepared as aids in that they suggest possible methods of presenting and utilizing with classes the audio-visual items in the accompanying packet. The thirteen schools participating in this program are:

A. J. Veraldi Junior High School, Middletown
Bronxville High School
Charles O. Dewey Junior High School, New York City
Chateaugay Central School
Draper Schools
East Greenbush Junior High School
Joan of Arc Junior High School, New York City
McArthur School, Binghamton
Niagara-Wheatfield Junior-Senior High School, Sanborn
Penfield Central School
Shenendehowa Central School, Elnora
Solvay High School
William Floyd High School, Shirley

The five basic packets and guides are presented to the schools at the start of the 1963-64 school year so that teachers will be able to use items whenever they best fit the curriculum. The items are not presented in any particular order, since it is not in any sense intended that the curriculum be shaped to their sequential use, but rather that individual items be selected by the teacher if and when they have potential for enriching the teacher's plan of work as the year progresses.

The materials contained in this packet of science lessons should be treated as purely supplementary material for the purpose of enriching instruction. An individual teacher may decide how much of the material enclosed to use. These materials have the same status in the State's science curriculum as that of other supplementary materials listed in handbooks, bibliographies, and special audio-visual publications. An effort has been made to correlate the cultural items with both the established and experimental programs in science for grades 7-8-9. There may be areas in which the teacher will not wish to explore the topics in depth. There is a danger that the teacher may be led into areas with which he is not proficient. The materials should in no way be considered a substitute for the established curriculum. Caution is advised against overburdening pupils with too much stress upon the follow-up activities; pupils may find themselves spending an excessive amount of time outside the classroon on such material.

The Project CUE curriculum coordinator, assigned by each participating school system will aid the teachers to gain a working knowledge of the contents of the packets and seek the teachers' evaluation of items in the packets, using the evaluation forms provided in this publication. The curriculum coordinator will prepare summaries of the teacher evaluations periodically. As the year progresses, the reactions and suggestions of the participating teachers and curriculum coordinators will be applied to the improvement of the packets and the guides so that a carefully screened, flexible packet for each of the five subjects and a similarly improved guide may be prepared.

The audio-visual specialist, assigned to Project CUE by the school system will see that the essential equipment is available for the effective use of the packets and assist the teachers to master the proper use of the equipment. In general it is planned that the schools will be provided with most of the materials listed in the guides.

Based upon the results in the thirteen schools, a revised guide will be published and made available for Statewide and national use at the close of the year. The guide will include results of a sampling of student and teacher interviews, designed to evaluate the effectiveness of the program.

Project CUE is being undertaken with federal funds under Title VIIB of the National Defense Education Act. It is a joint undertaking of the Division of Educational Communications and the Bureau of Secondary Curriculum Development, with the cooperation of Department specialists in the five subject areas involved. General planning for the experimental work to be done in the 1963-64 school year was participated in by the following staff members: Lee E. Campion, Director of Educational Communications; Loran C. Twyford, Chief of the Bureau of Classroom Communications; Robert M. Brown, project director; Mrs. Grace Lacy, associate director of the project; Vivienne Anderson, Acting Chief of the Bureau of Secondary Curriculum Development; Mildred F. McChesney, supervisor of social studies; Elnora D. Carrino, associate in English education, assigned to coordinate the English phase of the program by Walter V. Eddington, supervisor of English education; Hugh B. Templeton, supervisor of science education; Dorothy S. Lawson, Chief of the Bureau of Home Economics Education; Arthur F. Ahr, Chief of the Bureau of Industrial Arts Education. Vincent J. Popolizio, supervisor of art education, and Joseph G. Saetveit, supervisor of music education, served as consultants to the total project.

During the summer of 1963, the following consultants screened items for use in the five basic packets and drafted manuscripts for teacher guides in the following subject areas: social studies - Jerome Howard, teacher of social studies, Bronxville; English - William P. Manders, assistant principal and Project CUE coordinator, Bronxville; Edna W. Morgan, assistant principal, John S. Roberts Junior High School, New York City; Margaret Mary Walsh, language arts supervisor, Arlington Public Schools, Pleasant Valley; science - Austin Leahy, teacher of science and Project CUE coordinator, Draper Schools; home economics - Kathryn B. McKenna, teacher of home economics, Chateaugay Central School; and industrial arts - Adrian H. Wood, vice principal and Project CUE coordinator, Chateaugay Central School.

The following Department specialists conferred with the consultants on matters related to content during their period of summer work: Walter V. Eddington, supervisor of English education; Elnora D. Carrino, associate in English education, Mildred F. McChesney, supervisor of social studies; Robert G. MacGregor, associate in science education; Dorothy S. Lawson, Chief of the Bureau of Home Economics Education; Ruth-Ellen Ostler, associate in home economics education; Arthur F. Ahr, Chief of the Bureau of Industrial Arts Education; Arthur J. Dudley, associate in industrial arts education; Robert S. Seckendorf, associate in industrial arts education. Grace Lacy, associate director of the project, worked closely with the consultants and had collected numerous items for them to review for possible use in the packets prior to their arrival. Jewell Ginn, consultant to the Division of Educational Communications, served the group as editor. Audna Clum, librarian at Averill Park Central Rural High School, helped prepare the final copy for publication. Vivienne Anderson, Acting Chief of the Bureau of Secondary Curriculum Development, coordinated the efforts of the subject specialists, the secondary curriculum bureau, the communications specialists and the consultants, working with Robert M. Brown, Project CUE Director.

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## CONTENTS

About Time (Film)
Nuclear Energy . . . . . . . . . . . . . . . . . . . . . . . . . 1

Atomic Energy (Film)
Nuclear Energy . . . . . . . . . . . . . . . . . . . . . . . . . 3

Autumn Color (Film)
Color . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5

Circuits of the Senses (Flat pictures or slides)
Perception . . . . . . . . . . . . . . . . . . . . . . . . . . . 7

Color - Lecture 12. Harvey White (Film)
Light . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8

Color Illusions (Benhams disc, Color Wheels, Color Illusions) Light . . . . . . . . . . . . . . . . . . . . . . 9

Discovering Color (Film)
Energy. . . . . . . . . . . . . . . . . . . . . . . . . . . . . 11

Discovering Texture (Film)
Energy. . . . . . . . . . . . . . . . . . . . . . . . . . . . . 13

Drawing and Models of Inventions of Leonardo da Vinci (Slides) Machines . . . . . . . . . . . . . . . . . . . . . . 14

Flaming Sky (Film)
Light . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 17

Grand Canyon (Film)
Changes in the Earth's Surface. . . . . . . . . . . . . . 19

Light in Nature (Film)
The Nature of Science . . . . . . . . . . . . . . . . . . 21

Line (Film and flat pictures)
Motion. . . . . . . . . . . . . . . . . . . . . . . . . . . . . 22

Listening to Good Music (Film)
Sound and Music . . . . . . . . . . . . . . . . . . . . . . 25

## CONTENTS CONCLUDED

Metropolitan Seminars in Art (Flat pictures)
Perception . . . . . . . . . . . . . . . . . . . . . . 27

Nature's Half Acre (Film)
Ecology . . . . . . . . . . . . . . . . . . . . . . . 29

Playing Good Music (Film)
Music . . . . . . . . . . . . . . . . . . . . . . . . 30

Prehistoric Animals of the Tar Pits (Film)
Earth's Evolution. . . . . . . . . . . . . . . . . . . 31

Secrets of the Bee World (Film)
Living Things . . . . . . . . . . . . . . . . . . . . 33

Sense Perception (Film)
Perception . . . . . . . . . . . . . . . . . . . . . . 35

Science of Sound (Recording)
Sound. . . . . . . . . . . . . . . . . . . . . . . . . 37

Slide Lecture by National Gallery (Slides and booklet)
Light. . . . . . . . . . . . . . . . . . . . . . . . . 40

Sound Waves and Their Sources (Film)
Sound Waves. . . . . . . . . . . . . . . . . . . . . . 41

World is Born (Film)
Origin of the Earth. . . . . . . . . . . . . . . . . . 43

Curriculum Area: Science - Nuclear Energy (relativity)

Cultural Item: (Film) "About Time"
2 parts. 30 min. each. (color)
Bell Telephone Company

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Preparation of the Class:

While studying nuclear energy or earth movements, the film "About Time" might be presented to give the pupil a broader concept of time. Indicate that time is not a hard and absolute thing but rather is relative depending on the way in which it is perceived.

Pupils Should Look For:

- Early methods of telling time
- Internal clocks in nature
- Way in which Galileo's discovery revolutionized methods of timekeeping
- Improvement in accuracy of timekeeping
- The small part of time man has existed, in relation to the time continuum
- The idea that time is relative depending on the way it is perceived

Pupils Should Listen For:

- Theory of what time is
- The importance of time as it exists beyond our familiar everyday concepts of time
- The concept of time as relative rather than absolute

Presentation of the Film.

Follow-up Activities:

To reinforce pupil learnings, organize a discussion around the following questions.

(1) How did man originally tell time?

(2) Why did man use heavenly bodies upon which to base time?

(3) What are some examples of internal clocks observed in plants and animals?

(4) What were some methods man first employed to keep track of time?

(5) How did Galileo's discovery revolutionize timekeeping?

(6) Why is there some inaccuracy in pendulum clocks?

(7) Why doesn't the movement of the earth form a perfect clock?

(8) Why is it important that time be measured in infinitesimal units?

(9) How do we know that there was once water where mountains and land areas now appear?

Curriculum Area: Science - Nuclear Energy

Cultural Item: (Film) "Atomic Energy" 10 min. (black and white). Encyclopaedia Britannica Films

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Preparation of the Class:

(1) This film may serve as an introduction to a unit on atomic energy. Emphasize to the pupils that matter composing the universe is made of particles having definite form and structure. All matter is composed of molecules, and molecules are composed of atoms. Even though these atoms may differ in the number of particles, the arrangement of these particles follows a definite pattern from the simplest atom to the most complex one. Any time there is a change made in this arrangement or pattern, either natural or induced, energy transformations take place.

(2) Introduce and explain briefly the following terms:

(a) Fission - A nuclear reaction in which a heavy element is split (separated) into two nearly equal parts with the simultaneous release of energy and neutrons.
(b) Fusion - Thermonuclear reaction, referred to as nuclear synthesis in the film--a reaction in which light elements are combined to form heavy elements with an accompanying release of energy.

Pupils Should Look For:

- Composition of matter
- Structure of matter -- arrangement of the composition of matter
- Combining of atoms
- The way in which electrons gain and release energy
- Energy release of atoms
- Chain reaction effect set off by neutrons
- Release of energy through fission
- Release of energy through fusion

Presentation of the Film.

Follow-up Activities:

(1) Discuss the following questions.

(a) All matter is composed of molecules. What are molecules composed of?
(b) What are the three principal particles that compose the atom?

(c) Describe the definite arrangement of the particles within the atom.
(d) How is solar energy stored on earth?
(e) What ways do we have of releasing solar energy?
(f) What initiates the fission process?
(g) What makes the fission process continue as a chain reaction?
(h) Where does the energy come from during a fission reaction?
(i) What occurs within the atom when it gains energy?
(j) What is a fusion reaction?
(k) How does the sun release energy?
(l) What is the principal difference between a chemical reaction and a nuclear reaction?

(2) Some pupils may prepare a report on some of the following:

(a) The uranium isotopes
(b) Atomic fission
(c) Nuclear reactors
(d) Plutonium production
(e) Peace time uses of atomic energy

**Curriculum Area:** Science - Color

**Cultural Item:** (Film) "Autumn Color"
7 min. (color). Thorne Films

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**Preparation of the Class:**

In "Autumn Color," the camera has provided an unusual approach to composition, texture, color, and lighting. Accompanied by a subtle piano improvision, the film helps to awaken an awareness of artistic qualities inherent in nature.

**Pupils Should Look For:**

- The way in which the music seems to establish moods that conform with color scenes
- Art forms in nature
- Color contrasts in nature
- Beauty in simplicity
- Effect of lighting on photographic subjects
- The following scenes:
  (As a means of making the film more informative, write the following as a guide for the pupils under the heading "Scenes that you will see include")
  Yellow of cottonwood against a mountain background
  Locust tree and milkweed, then the orange and red of plum, sumac, and hawthorne and the subtle hues formed by Virginia creeper leaves
  Gold of cottonwood against the dark shadow of a canyon and the flickering effects of quaking aspen in the wind
  The contrasting yellow and orange of the sugar maple followed by the brilliant red of sumac and barberry
  The variety of color, light, and textures exemplified by oak leaves
  In the final scenes, sugar maple against a mountain background

**Presentation of the Film.**

**Follow-up Activities:**

(1) Some points to develop with the pupils might be:

(a) Many of the scenes just witnessed are beauty in our everyday environment that a majority may tend to overlook.

(b) Photography enables us to capture scenes that we can view over and over for our aesthetic enjoyment. It also helps us to see beauty, pattern, form and texture so that we are more perceptive of these elements in our environment. The technique used by the photographer was to frame certain scenes in a manner which made them stand out. Framing helps us exclude extraneous material and concentrate on a certain section so we perceive it more thoroughly.

(2) Have some pupils photograph scenes in nature which have interesting design and texture color. Arrange these in an exhibit.

Curriculum Area: Science - Perception

Cultural Item: (Flat picture or slide from Life)
"The Circuits of the Senses" from Life
magazine, June 28, 1963, page 64
(See tear sheets in the packet.)

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## Preparation of the Class:

Give a brief explanation of the significance of the picture or slide by discussing the following points.

(1) The network of nerves depicted, representing the nervous system of man

(2) The various surrounding objects shown in the picture representing stimuli which affect his senses

(3) The nervous system as shown reacting to the sound of the
- Church bell
- Fragrance of flowers
- Flame of a match
- Movement of the clouds
- Light of the stars and the moon

## Presentation of the Pictures and Slides.

## Follow-up Activities:

Discuss the following questions with the pupils as they view the picture.

(1) By what means is man able to react to the rose, the bee, the burning match, and the light of the moon and the stars?

(2) How does he blend these stimuli into a single feeling of well-being?

(3) Why has the artist painted the objects surrounding the figure gray and colored them only in the man's brain?

(4) Do you think these objects might look the same to a bird or a dog?

(5) Do colors and objects always look the same to different people? Explain.

(6) Why do certain people have fear reactions when they hear a bee buzz or a snake hiss?

(7) Do your senses ever fool you?

Curriculum Area: Science - Light (color)

Cultural Item: (Film) "Color - Lecture 12. Harvey White"
30 min. (color). Encyclopaedia Britannica Films

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Preparation of the Class:

Briefly review with the class the learnings from previous lesson on mixing pigment. Discuss with them, that the results of mixing colored lights are sometimes quite different than mixing pigments. The films show these results.

Pupils Should Look For:

- The additive primary and secondary colors
- What happens when complementary light colors are added together
- The subtractive chart

Pupils Should Listen For:

- The Young-Helmholtz theory of how we see color
- The cause of color blindness or deficiency in color perception

Presentation of the Film.

Follow-up Activities:

(1) Ask the pupils to draw the light color triangle and interpret it.

(2) Ask the pupils to contrast the subtractive pigment chart with the additive chart.

(3) Ask them to find out why we experiment with colored lights.

(4) Ask the pupils if they think such experimentation with light has any purely scientific use.
(Experimentation is going on with special glasses to enable us to see light that is ordinarily invisible to us. This enables police and scientists to literally "see" in the dark.)

(5) Ask pupils if they can think of other scientific applications for experimentation that has been done with light.

Curriculum Area: Science - Light (color)

Cultural Item: "Color Illusions"
(Benhams Disc, Color Wheels, Color Illusions)

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Preparation of the Class:

Explain that pigments and dyes (objects) have color because they reflect or transmit only certain colors and absorb others. Color may also be produced by the refraction of white light. The blue of the sky is produced by moisture in the air which scatters the blue rays of the sunlight more than it does the red rays.

Films of liquids, such as oil on water or soap bubbles, produce color. Colors on insects or birds' wings result not from pigment but from the way in which light is refracted from the surface. Color is an experience of the retina; seeing color is filled with additional reactions called illusions.

Presentation of Benhams Disc and Color Discs and Illusions:

Use Benhams disc from this packet. Place the disc on a pencil point and spin slowly. When spun to the right, the inner rings will be red and the outer rings blue. When spun to the left, the order of the colors will appear to be reversed; this illustrates color illusion.

Pupils Should Participate In:

(1) Staring intently for about twenty seconds at a brightly colored object and then quickly transferring their gaze to a white background. They will see the complementary color on the white background because of retinal fatigue.

(2) Staring at color image of Lincoln Sample No.1 (included in pack) for one minute; then staring at white wall or screen. Pupils will see complementary colors.

(3) Rotating color disc from this packet. Persistence of vision will cause the disc to appear white.

(4) Staring at a frosted lighted electric lamp for thirty seconds, then closing eyes and describe what they see.

(5) Using kit sample No.2 to show how background makes a difference in appearance of color.

(6) Using color wheels provided in packet to show that color mixing actually takes place in the eye.

Follow-up Activities:

Discuss the following points with the class.

(1) The knowledge that science has provided about color has been utilized by artists to produce many unusual effects. Illustrate.

(2) Knowing the scientific facts about color helps us to enjoy and appreciate color and painting more for then we see it with more perceptive eyes. Illustrate.

(3) Summarize the observations and conclusions made about color illusions.

Curriculum Area: Science - Energy (Light)

Cultural Item: (Film) "Discovering Color"
16 min. (color). Film Associates of California

---

Preparation of the Class:

Review briefly with the pupils the appearance of color when light is passed through a prism. Ask the pupils what basic colors are produced in this manner and the arrangement of these colors. Then indicate to them that the film they are about to see will illustrate some of the results of color mixing as well as demonstrate how some variations are produced within an individual color.

Pupils Should Look For:

- The three principal ways in which colors differ
- Primary hues
- Secondary hues
- Examples of the basic hues in everyday surroundings

Presentation of the Film.

Follow-up Activities:

(1) Discuss the following questions.

(a) What are three ways in which colors differ?
(b) What are the basic hues?
(c) What are the primary hues?
(d) Which colors constitute the secondary hues?
(e) How can the value of a hue be changed?
(f) How can the intensity of a hue be changed?
(g) What hues are considered warm?
(h) What hues are considered cool?

(2) If some of the basic pigments are available among the art supplies, the pupils may perform some color mixing experiments which they have seen, such as;

(a) Using primaries to mix secondaries
(b) Using primary and secondary to mix tertiary
(c) Changing values
(d) Changing intensities

(3) Using the opaque projector, show the portrait paintings in the booklet as examples of warm and cool colors.

(4) Show the following paintings from the same booklet:
- Gauguin's "Siesta" as an example of color contrast

- Watkin's "The Sideboard," as an example of gentle graduation of color
- Picasso's "Le Gourmet" as an example of monochromatic color
- Monet's "Poplars," as an example of the prismatic color painted by the impressionists

(5) Encourage pupils to find such types of color use in the National Gallery of Art Paintings which are hung about the school.

Curriculum Area: Science - Energy (light)

Cultural Item: (Film) "Discovering Texture"
17 min. (color). Film Associates of
California

---

Preparation of the Class:

This film will create an awareness of the importance of texture. It will point out some of the beauties in nature that are determined by texture. The importance of good grooming habits may also be discussed with the pupils.

Pupils Should Look For:

- Ways in which we learn about texture
- Different kinds of texture
- Varieties of beautiful texture in nature
- Part played by light in producing textures
- Ways in which different textures may be produced
- Ways in which photography helps us to see textures that we might otherwise overlook

Presentation of the Film.

Follow-up Activities:

(1) After viewing the film, ask the following questions.

(a) What is texture?
(b) What are some of the different textures?
(c) What are the ways in which we learn about texture?
(d) What are some ways to create texture with paints? With crayons?
(e) Of what importance is texture?
(f) Where do we make use of texture in our daily lives?

Point out that everything we know of texture we perceive through our senses. Emphasize the importance of light in enabling us to discover texture.

(2) Ask pupils to bring to class some object they find in nature with interesting texture, such as bark, rock, wood, shells, clay. Arrange an exhibit of these materials and allow pupils to describe their textures to other members of the class.

Curriculum Area: Science - Machines

Cultural Item: (Slides) "Drawings and Models of Inventions of Leonardo da Vinci" 12 frames. (black and white and color). International Business Machines

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Preparation of the Class:

(1) Ask the pupils the following questions to establish desirable background information.

(a) Who was Leonardo da Vinci?
(b) What did he do?
(c) Do you know of any of his scientific inventions?

Most of the pupils will associate the name of Leonardo da Vinci with his paintings, but many will be surprised to learn the large number of inventions attributed to him.

(2) Explain that to da Vinci, the study of nature was a corollary to being a painter. His scientific studies took him into the field of geometry, optics, and mechanics, biology and zoology, geology and geophysics. According to da Vinci, it was logical for a painter to be a scientist since his knowledge as well as his ability to represent things is based on vision or the way he perceives things.

(3) The teacher should indicate to the class that in the slides to be seen, a model of one of da Vinci's inventions and then a picture of da Vinci's original drawings from which the model was later constructed will be shown.

Presentation of the Slides:

No.3 Model of an automatic drum - No.4 Drawing of an automatic drum.
As this device is wheeled along the ground, the gear fixed to the axle turns the two drums which trip five spring-loaded drumsticks on each side. (This is the principle upon which musical toys and music boxes of today operate.)

No.5 Model of a steam gun - No.6 Drawing of the steam gun
A projectile was discharged with steam pressure created behind it by water flowing into the barrel which was kept red hot by live coals. ( Its range reputedly was over two miles.)

No.10 Model of paddle wheel ship - No.11 Drawing of paddle wheel ship.
Wheels were to be turned by men working the cranks.

No.15 Model of hydraulic pump - No.16 Drawing of hydraulic pump.
The original structure was over 70 feet high. Erected beside a stream, it used the power of the stream itself to pump water 33 feet up to the Castle of Milan.

No.17 Model of parachute - No.18 Drawing of parachute.
Pyramid-shaped "tent of linen," as da Vinci called it, was believed to have been successfully tried in his own day from a tower especially built for the purpose. Can you see the optical illusion in this model?

No.21 Model of a flying machine - No.22 Drawing of the flying machine.
The flier was to lie in a wooden frame, steering the machine by a windlass while he flapped his wings by working a treadle.

Follow-up Activities:

(1) Develop a class discussion centered around the following questions.

- (a) Do you think it would be possible for a man today to be as versatile as da Vinci was? Why or why not?
- (b) Do you think da Vinci's ideas were advanced for his time? Why?
- (c) Do you think da Vinci would have been so versatile if he had confined his learning to one field only?
- (d) Upon what principle was his invention of the parachute based?
- (e) Our society has great need of inventive creative solutions to the enormous problems which face it. What kind of education do you think would produce creative inventive people?
- (f) Of what value is the parachute in our present day society?
- (g) Leonardo da Vinci's hydraulic pump might well be called the forerunner of modern hydraulic engineering. What important uses are made of hydraulics today?

(2) The teacher may wish to have some pupils who are involved in industrial arts construct one of the simpler models, such as the paddle wheel ship.

(3) Some excellent bulletin board displays may be constructed by the pupils which will illustrate:

(a) Various uses of Archimedes' principle
(b) How the principle of Archimedes is employed in ship building
(c) How laws of hydraulics are used in planning city water systems
(d) Pascal's law as utilized in the design of the automobile brake system

Curriculum Area: Science - Light (spectrum)

Cultural Item: (Film) "The Flaming Sky" 29 min. (color).
McGraw-Hill Films

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Preparation of the Class:

One of the most interesting phenomena that exists in the atmosphere is the aurora, more commonly called the "northern lights." This film explains in detail the what, why, and how of this spectacular display.

(1) Ask how many of the pupils have observed the "northern lights."

(2) Point out that optical instruments show that this light is nearly always present in the sky but is usually too faint to be seen.

(3) Explain that this phenomenon occurs as a result of radiations from the sun being diverted toward the magnetic poles of the earth.

(4) Indicate to the pupils that this phenomenon is called the aurora borealis in the Northern Hemisphere and the aurora australis in the Southern Hemisphere.

Pupils Should Look For:

- The different instruments that scientists use to expand our perception of this phenomenon and how these instruments are used
- The influence of the earth's magnetic field on these radiations
- The analysis of auroral light by means of a spectrograph
- Recent developments in rocketry
- Recent developments in photography

Pupils Should Listen For:

The reasons why radiations cause the atoms in the atmosphere to emit light

Presentation of the Film.

Follow-up Activities:

(1) Discuss the following points with the class.

(a) The similarity of fluorescent lighting to the phenomenon of the aurora

(b) That "Aurora" was the name of the goddess of dawn in Roman mythology
(c) That this phenomenon has its greatest prominence when sunspot activity is at its peak
(d) That during greatest sunspot activity, long range radio communications are jammed

(2) Ask the following questions of the class to review the film.

(a) What is the source of radiations that produce the "northern lights?"
(b) What magnetic field is it that affects the radiations to produce the aurora?
(c) Why are these solar radiations affected by the magnetic field of the earth?
(d) Why is the aurora more prominent near the polar regions?
(e) What are sunspots?
(f) What time cycle do the sunspots appear to follow?
(g) Why is the phenomenon of the northern lights greatest during sunspot activity?
(h) Why are radio communications affected by solar radiations?

Curriculum Area: Science - Changes in the Earth's Surface

Cultural Item: (Film) "Grand Canyon"
29 min. (color). Walt Disney Films

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Preparation of the Class:

The Grand Canyon is well known for its impressive beauty, its towering buttes, mesas, and the valleys within its main gorge. Located in Arizona, where it is continually being eroded out by the Colorado River, this wonder of nature has been in the formative stage for about one million years according to geological estimates. How do you think geologists arrive at a figure such as this for the age of the canyon?

Evidence found in the rocks of the canyon wall indicate that for long periods of time the canyon area was the bottom of a shallow sea. What evidence do you think was found indicating this? (Most of the strata were originally deposits of marine sediments.)

Although the canyon itself is of recent origin by geological standards, the rocks exposed in the canyon wall are not. As the different rock layers are dated, beginning at the top of the canyon and continuing to those at the bottom, the rocks in the lower strata have been found to date way back to the Pre-Cambrian era, which makes them between a half-billion and a billion years old. How are archaeologists able to date these various strata formations? (radiological dating)

The canyon, over 200 miles in length, has depths of over one mile. In this film you will see a panorama of this wonder of nature which has been rightfully named one of the seven wonders of the world.

Pupils Should Look For:

- Variety of hues in rock formations
- Different kinds of plant life
- Rock features indicating considerable faulting
- Color, pattern, and texture in the rock and mesas
- The awesome beauty of nature

Pupils Should Listen For:

The music of the "Grand Canyon Suite" as composed by Ferde Grofe. Much of his music describes the American scene.

Presentation of the Film.

Follow-up Activities:

(1) Discuss the following questions.

- (a) Different climatic regions in this area have given rise to different types of vegetation. What are some types of vegetation that you saw?
- (b) What animals find a natural habitat here?
- (c) What influence do you think radioactive dating has had on our understanding of this land formation?
- (d) In what ways has this area aided geologists in their quest for knowledge?
- (e) Describe how this natural beauty seemed an inspiration for Grofe's musical composition.
- (f) Do you think visiting the Grand Canyon would make you feel the vastness of nature and the smallness of man and his accomplishments in comparison?

(2) Have the pupils arrange a bulletin board display which depicts the various eras through which this land formation has evolved.

(3) Make a roll (picture-strip) for projection on the opaque projector containing comments and musical background which suit the projected pictures.

**Curriculum Area:** Science - The Nature of Science

**Cultural Item:** (Film) "A Light in Nature"
35 min. (color). Shell Oil Company

### Preparation of the Class:

Scientific exploration continually answers old questions and gives rise to new ones. Man's continual quest for knowledge promotes this scientific research. In this film you will see some of the directions this search is taking at present. Our scientific methods today are based primarily on the very same procedure used by early scientists; namely, arrange your thoughts, begin with simple objects or ideas, diligently inquire into the properties of things, and proceed slowly from hypothesis to the explanation.

### Pupils Should Look For:

- The "evidence to reasoning" approach by scientists
- Advances in the field of atomic makeup
- Scientific investigation in the area of photosynthesis
- Investigations for the purpose of explaining life itself
- Cell division
- Experiments with the nervous system of humans
- Improved exploration of the heavens

### Presentation of the Film.

### Follow-up Activities:

(1) Prepare a report which demonstrates how a given scientist applied the "evidence to reasoning" approach to his particular discovery.

(2) Prepare a brief report on the cyclotron as it is used in the study of atomic particles.

(3) Prepare a brief report on the DNA molecule and its importance to life.

Curriculum Area: Science - Motion

Cultural Item: (Film and flat pictures) "Line"
11 min. (color). McGraw-Hill Films
Metropolitan Seminars in Art
Plate 95 (Portfolio 8)
Plates 111 and 112 (Portfolio 10)
Plate 25 (Portfolio 3)

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Preparation of the Class:

(1) This film can be used to develop a relationship between some of the laws of nature and show how use is made of them in artistic design. It can serve to increase the perception of the pupil while he simultaneously learns the physical laws of nature.

(2) Indicate to the class that things such as motion, symmetry, and balance (center of gravity) are elements of design used by many painters. However subtle they may be, these elements of design are there and they influence the perception of the observer.

(3) In this film are shown the ways the artist uses line to produce effects of motion, direction, and boundary in composition.

Pupils Should Look For:

- Characteristics of line
- Ways in which motion is implied by the attitude of a line
- Way in which motion is implied by line curvature
- Movement portrayed by association
- Ways in which line is suggested by points of interest
- Ways in which lines can guide our eyes through a design
- Use of dots or broken line to give the impression of line
- The qualities of line

Presentation of the Film.

Follow-up Activities:

(1) Discuss the following questions with the class.

(a) Why do oblique lines tend to disturb us?
(We expect motion to occur because the line is not balanced. There is a similarity here to the center-of-gravity principle which directly or indirectly influences our daily thinking.)

(b) How does an artist portray movement of association?
(Lines representing familiar things such as trees, waterfalls, and waves immediately imply motion to us.)

(c) What feeling of motion do we get from a horizontal line?
(Since we normally read from left to right, a horizontal line gives us the impression of movement toward the right, unless it is stopped by an opposing line.)

(d) How do curved lines give us the impression of motion?
(Our familiarity with such things as water waves or billowing smoke tend to create a feeling of motion in the direction of the bulge in a curved line.)

(2) Illustrate some of the simple techniques of line as composition using the following prints from the "Metropolitan Seminars in Art."

(a) Plate 95 (Portfolio 8) "Sugar Cane" by Rivera.
Point out how the figures on the extreme left and right are like pillars and serve as the boundaries of the painting. The attitude of the lines which characterize the native workers in the background give the feeling of motion to the left, but this motion is stopped by the figure on the left. In a similar manner the attitude of the line around which the workers in the foreground were composed seems to imply movement to the right, but this movement to the right is stopped by the line of the stalwart figure there.

(b) Plate 111 (Portfolio 10) "Sloop, Bermuda" by Homer.
Point out the use of line here to illustrate motion of water waves and also to give the impression of billowing clouds in the sky.

(c) Plate 112 (Portfolio 10) "Boat off Deer Isle" by Marin.
There is little subtlety here in the use of line. This artist abstracts the scene. He is more interested in line form and design than in subject. Note how the bold strokes of the water colors produce lines that enclose the boat in the center. There is some semblance of the triangular form in the brash use of the brush strokes.

(d) Plate 25 (Portfolio 3) "The Starry Night" by Van Gogh.
Here the artist uses line to portray motion in an attempt to create feelings of emotion in the observer. This is characteristic of Van Gogh's style of painting, the twisting cypresses, the swirling arcs about the stars reveal the intensity of his emotion. As our eyes follow these contorted lines we in turn experience the intensity of his creation.

(3) Some pupils may wish to use line in sketches or compositions to produce effects of balance and movement.

(4) The teacher may wish to review optical illusions and how line is related to their creation. Pupils may supply examples of optical illusions for the class to observe and discuss.

Curriculum Area: Science - Sound and Music

Cultural Item: (Film) "Listening to Good Music"
14 min. (black and white).
Encyclopaedia Britannica Films

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Preparation of the Class:

While studying sound and music, this film can be introduced to develop in the mind of the pupil the concept of music as a means of communication or as a kind of language which may be used to tell a story. In the film a string quartet is shown and the instruments involved are explored as to their origin, function, and ways they combine to produce various types of music.

Pupils Should Look For:

- Sound made by each instrument and origin of the instrument
- Frequency range of each instrument and its placement in a quartet or in a musical composition as based on its frequency range
- Difference in sound quality of the various instruments
- Different moods expressed in music

Presentation of the Film.

Ask the following questions.

(1) What four instruments made up this quartet?

(2) Which instrument plays the lowest pitched sound?

(3) Which instrument plays the highest pitched sound?

(4) How much do you think the best quality violin available would cost?
(The pupils may be surprised to learn that some people will pay as much as $100,000 for a Stradivarius violin, made around the beginning of the 18th century. Although Stradivari made around 1,200 stringed instruments, it is estimated that there are less than 400 in existence today.)

(5) What produces the difference in sound quality (tonal color) of the instruments?
(Difference in sound quality depends on overtone series and what each instrument does with its overtones.)

(6) Which voice range does the cello play?

(7) Which voice range does the viola play?

(8) Why do you think the violin plays in the soprano and alto range?
(The violin is a smaller instrument with shorter strings and thus higher pitch.)

(9) What were some of the moods expressed by the music of the quartet?

(10) What other kinds of instrumental quartets might you have?

Additional Suggested Materials:

Film: "Music, The Expressive Language"
10 min. (color). Sutherland Films

Curriculum Area: Science - Perception (illusions)

Cultural Item: (Flat pictures) Metropolitan Seminars in Art
Plates 25, 31, and 34
(Portfolio 3)

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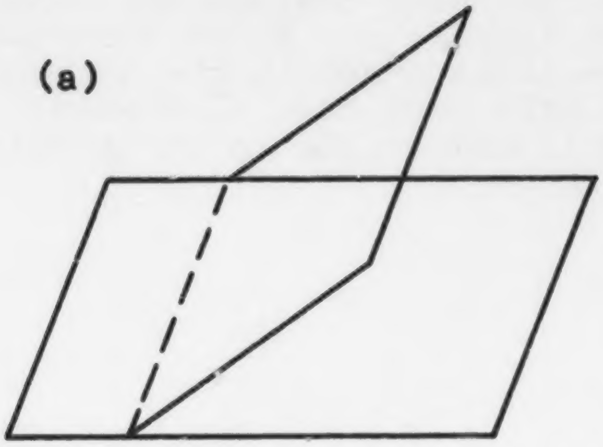
Preparation of the Class:

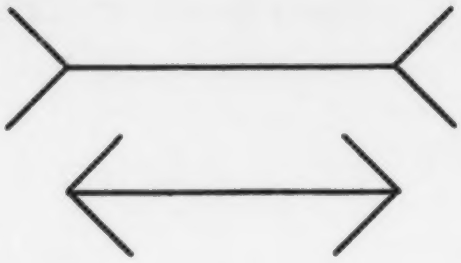
(1) We know that, amazing as our senses are, we perceive only a very small part of the universe (of reality). We have also learned that in our perception of even the small part of reality, our senses are imperfect. Optical illusions are amusing examples of how our senses can deceive us.

(2) Present charts of the following illusions and discuss some interpretations with the pupils.

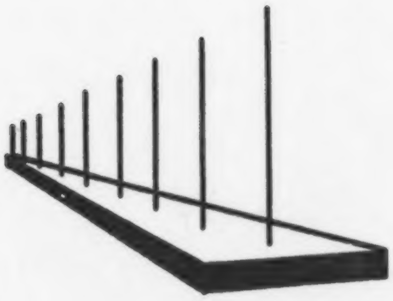
(a)



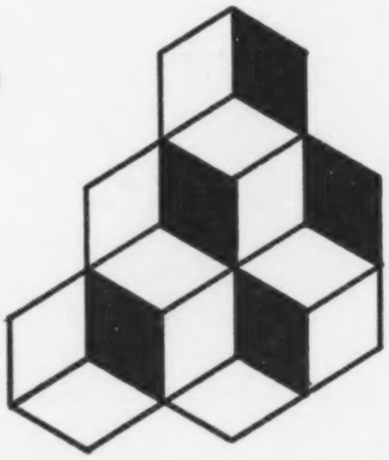
(c)



(b)



(d)



Follow-up Activities:

We find that we can be deceived by simple arrangement of lines or shapes. How much more easily, then, can we be deceived by facts and objects we observe in nature? Additional examples of simple illusions to give pupils follow:

(1) If two cars, A and B, are moving in the same direction, and if A is moving faster than B, then B will appear to be moving backward relative to A.

(2) A piece of plate glass can be set up vertically on the table with a light bulb on each side. The light bulbs must be in line perpendicular to the plane of the glass and equidistant from the glass. Properly positioned, when the light bulb on the side near the pupil is turned on, the other bulb will also appear to be lighted. This phenomenon of mirror images points out how we may be deceived by what we see.

(3) Three jars of water (cold, lukewarm, and warm) may be used to show how our body can sense temperature only in relative terms. If the fingers are first immersed in the cold water and then transferred to the lukewarm water, the lukewarm water will feel hot. The water feels either warm or cool in comparison to our previous experience or frame of reference.

Curriculum Area: Science - Ecology

Cultural Item: (Film) "Nature's Half Acre"
35 min. (color). Walt Disney Films

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Preparation of the Class:

The teacher may indicate that this film will show some of the wonders of nature as they take place in natural settings. Undoubtedly, many of the scenes are similar to those that pupils have observed taking place around them. "If you would only take the time to stop and look, you would view a world of beauty of which perhaps you are unaware."

Pupils Should Look For:

- Various forms of insect life
- Different kinds of bird life
- Unusual animal habitats
- Beautiful hues in flowers
- Carnivorous plants
- Various methods that animals use to obtain food

Pupils Should Listen For:

- Familiar sounds of nature
- Melodious bird songs

Presentation of the Film.

Follow-up Activities:

(1) Discuss the following questions in stimulating a class discussion.

(a) What are some unusual methods used by animals to obtain foods? Give some examples.
(b) What were some of the outstanding characteristics of animals that you saw illustrated in the film?
(c) What was meant by the expression "balance of nature" as it was used in the film? Cite some examples.
(d) What evidence was given that substantiates the "survival of the fittest" theory?
(e) What was meant by the statement "The mud dauber's sting puts the spider in a state of suspended animation in order to serve later as food for the young mud daubers."

(2) Some pupils who have photography for a hobby may wish to prepare a display of their photographs which attempt to capture some of the beauty of nature.

Curriculum Area: Science - Music

Cultural Item: (Film) "Playing Good Music" 15 min. (black and white). Encyclopaedia Britannica Films

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Preparation of the Class:

We appreciate music to the extent that it conveys meaning to us or produces a response in us. Thus, the more we know about how music is produced, the better we are able to grasp the feeling or meaning which the composer intended.

Pupils Should Look For:

- Techniques in playing individual instruments
- The method of changing pitch in stringed instruments
- The finger action on the strings when vibration is used
- A way of varying amplitude of sound

Pupils Should Listen For:

- Richer sounds with many notes sounding simultaneously
- Vibrato in music
- Varying rhythmic patterns
- Theme moving from one instrument to another

Presentation of the Film.

(1) Discuss the following questions.

   (a) What technique is used by the musicians to change the pitch of the instruments?
   (b) How is vibrato produced?
   (c) What technique is used to increase amplitude? To decrease amplitude?
   (d) How does the composer emphasize a single idea? (The four voices play a single note in unison.)
   (e) What are some things a good musician must be cognizant of in order to perform his part well?

(2) Ask some of the pupils involved in music to bring instruments to class and have them demonstrate some of the various techniques. (The greater the variety of instruments, the better.)

Curriculum Area: Science - Earth's Evolution

Cultural Item: (Film) "Prehistoric Animals of the Tar Pits"
14 min. (color).
Film Associates of California

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When fossilization is studied in the earth science area of general science, the film "Prehistoric Animals of the Tar Pits" may be used to acquaint the pupils with some of the methods used, and one of the areas explored, by present day archeologists.

## Preparation of the Class:

Explain that clues to past life have been preserved in tar, wax, coal, ice, and stone. These clues may be in the form of shells, bones, tracks, eggs, imprints, or entire mummies. The teacher may indicate that the film shows an area in which archeologists have uncovered a wealth of information about prehistoric animals. It is about the tar pits of La Brea, which is now a county park in California.

## Pupils Should Look For:

- Way in which scientists believe the tar pits originated
- Methods of sorting fossils
- The things paleontologists learn from these fossil discoveries
- Types of prehistoric animals found in La Brea
- Theoretical view of La Brea 40,000 years ago

## Presentation of the Film.

## Follow-up Activities:

Questions such as the following should be presented following the film to stimulate class discussion.

(1) What are fossils? What are some ways in which they are formed?

(2) What do fossils tell us?

(3) How old are the fossil remains found in La Brea?

(4) What is a paleontologist?
How do paleontologists help us reconstruct our ideas of the world's past?

(5) What are some of the prehistoric animals of the tar pits?

(6) How did the animals come to be in these pits?

(7) How are paleontologists able to date prehistoric animals? (Radiocarbon dating)

The scientific basis for radioactive dating with carbon should be explained to the pupils.

All living plants and animals take in radiocarbon from the air. After the organism dies, the carbon loses radioactivity at a fixed rate. By checking the radioactive emission rate from fossil remains, archaeologists are able to tell how long the object has been decaying.

Cosmic radiations entering the atmosphere smash atoms in the air resulting in several various atomic particles, one of which is the neutron. When neutrons collide with nitrogen atoms in the air, they cause the nucleus to emit a proton resulting in a carbon atom which is radioactive. This radiocarbon has a half-life of 5,600 years.

Since we can tell the number of disintegrations given off per hour from a living organism, we can date a fossil remnant by its amount of radioactivity because we know that the number of the disintegrations will decrease by one-half the original amount every 5,600 years. By this method scientists are able to date prehistoric organisms to around 40,000 years ago.

Carbon dating is an important method of placing in time artifacts which are found by the archeologist. Thus both the paleontologist and the archeologist help the scientist and historian reconstruct the past. By knowing about the past both in nature and in history, we can prognosticate about the future.

Additional Suggested Materials:

Book: "Evolution"
Life Nature Library

This is a text with excellent illustrations depicting the stages in the evolution of the earth.

Curriculum Area: Science - Living Things (adaptations)

Cultural Item: (Film) "Secrets of the Bee World"
13 min. (color). Walt Disney Films

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Preparation of the Class:

(1) Since this film deals with one phase of the insect world, it might well be introduced during the study of living things. It should serve to instill in the pupils a greater understanding of, and appreciation for, some of the marvels of nature's workings.

Much of life that exists around us, we tend to take for granted. Whereas most of man's behavior is the result of reason, the majority of animal behavior is of an instinctive nature. Yet these instincts which guide their actions are, in many ways, more precise than the reasoning which guides man's behavior.

(2) As a means of arousing interest, the teacher might discuss some of the following topics.

(a) Fear of fire in most animals
(b) Courtship of the peacock
(c) Migratory habits of birds
(Scientists think that changing amounts of daylight change the amount of a certain hormone in the bird's body which leads to migration. This is the only one possible explanation.)
(d) Hibernation habits of certain animals
(e) Flight of the bee in search of nectar, and the direction taken after a nectar source is found
(f) Flight of homing pigeons

Pupils Should Look For:

- The way bees make honey
- The use of form in construction of honeycombs
- The way nature provides for perpetuation of the bee world
- Instinctive behavior in these insects
- The way each insect seems to understand and perform his part in the working group

Presentation of the Film.

Follow-up Activities:

(1) Discuss the following questions.

(a) What is the function of the queen bee?
(b) How is the queen bee selected?

(c) What is it that almost makes you think the honeycomb was constructed by reasoning? (It provides for maximum storage with minimum space.) Can you see the pattern?
(d) How is honey produced? Can it be produced synthetically?
(e) What are the functions of the worker bee?

(2) Things that might be pointed out.

(a) After mating with a drone the queen bee can lay eggs for the rest of her life.
(b) She may lay 2,000 eggs a day or up to 1,000,000 eggs in a lifetime.
(c) The worker bee is the one that stings.
(d) The drone bee has no sting.
(e) Honeybees are able to identify sweet, sour, salty, or bitter tastes.
(f) The walls of a honeycomb are only about 1/80 of an inch thick, but can support 30 times their own weight.
(g) A bee has five eyes--three small ones on top of its head and a large compound eye on each side of its head. Each compound eye contains thousands of individual eyes. The microscope and microphotography help to reveal to us the beauty and pattern of the microcosm as well as revealing the remarkable structures of nature which often give men ideas for invention and creation.

Curriculum Area: Science - Perception

Cultural Item: (Film) "Sense Perception"
2 parts. 27 min. each (color).
Moody Institute of Science

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Preparation of the Class:

Review briefly with the class the ways in which our senses can sometimes fool us. Some of the following points may be presented to the class prior to viewing the film.

Man's brain and nervous system are among the true marvels of the world or perhaps even the universe. The brain can take all the sensory stimuli fed into it by the sense organs, millions of messages per second, and make sense out of all these signals. It can associate, remember, have inspirations beyond the reach of the most complex computer. Yet, unless we are trained to perceive widely and accurately, we can misinterpret the signals sent to the brain. It is important, therefore, to know about the limitations of our senses, for all we know of reality we learn through those senses.

Has it ever occurred to you that perhaps there is much more to see and hear and experience in this world than you have experienced? Let us view this film to find out what you may have been missing.

Pupils Should Look For:

- The small part of the electro-magnetic spectrum which man can see
- The way that the eyes prove that hearing is limited
- One of the senses which is so crude and limited that it must be aided by another sense
- The Ames optical illusion and what it proves

Pupils Should Listen For:

The sound of the dog whistle (ultrasonic sound)

Presentation of the Film.

Follow-up Activities:

(1) Review the points raised in the items under "Pupils Should Look For."

(2) Discuss the following questions.

(a) How is the meaning we attach to stimuli affected by past experience?

(b) If we are more aware of our sensory limitations, in what ways would this affect our judgment and behavior?
(c) How would realizing that people perceive things differently help you to understand and get along better with others?
(d) How is technology contributing toward strengthening our perception of reality?

(3) Through discussion, develop the following understandings.

(a) Man has always been striving to extend his control over his environment.
(b) Machines which man has invented, such as the lever, the wheel, the pulley, the screw, and the engines are extensions of man's muscle power.
(c) Other technological inventions extend the power of man's senses, for example:

- The telescope and microscope extend visual power.
- Radar and sonar extend hearing.
- Microphones and radio extend the power of the voice.
- Computers are extensions of brain power in certain areas of computation.
- Radio, television, and Telstar widen man's areas of communication and will make it necessary for man to communicate effectively with peoples of different experimental backgrounds. Therefore, it is well to know as much about perception and communication as possible, so that he can interpret stimuli and messages effectively.
- Language is a symbolic means of communicating ideas.
- Art is a symbolic means of communicating feelings.

**Curriculum Area:** Science - Sound

**Cultural Item:** (Recording) "The Science of Sound"
(33 1/3 rpm.) Bell Telephone Company

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**Preparation of the Class:**

Since much of what we experience and enjoy is through our sense of hearing, it is important that the pupils understand why they hear what they do as well as the mechanics of how they hear. Even a small child will respond to music before he has any conception of how it is produced or the way in which he hears it.

The recording, "The Science of Sound," is excellent to use to reinforce concepts of sound and how musical variation is produced by arrangement of sounds from various musical instruments. The recording explains and illustrates all phases of sound and the way in which they relate to music.

**Pupils Should Listen For:**

- Range of audible frequencies
- Ways in which sound may be produced
- Ways in which pitch is varied
- Different classes of musical instruments
- Differences in quality of sounds
- Production of overtones
- Filtered music

**Presentation of the Recording.**

**Follow-up Activities:**

(1) Develop a discussion using the following questions as guides.

  (a) How is sound produced?
  (b) What is the frequency range of sounds we perceive?
  (c) What determines if a sound is musical or not?
  (d) What are some ways in which pitch is varied in musical instruments?
  (e) How is sound intensity varied?
  (f) How are overtones produced in musical instruments?
  (g) What enables you to distinguish between the sound of two different instruments even though they are producing the same pitch?

(2) To help pupils understand better some of the characteristics of sound, the teacher might have them perform the following exercises.

(a) To demonstrate changes in amplitude, clamp a meter stick on the edge of the table with three-fourths of the meter stick extending over the edge. First strike lightly and then harder and compare the loudness of the two sounds produced. Point out that the vibration rate does not change.

(b) To demonstrate pitch use the meter stick in the same position on the table as before but without the clamp. Strike the end of the stick and note the pitch of the sound. Now move the rule in so that only about half of it extends over the edge of the table. Again, strike the end of the stick and note the change in pitch. Point out as less of the stick is caused to vibrate, its rate of vibration increases, and thus the pitch of the sound increases.

(c) To demonstrate how overtones are produced, construct a monochord. Using a piece of board about 40 inches long, drive two nails into the board so that they are 36 inches apart. Bend the tops of the nails slightly toward each other and tie a piece of nylon fishing line near the heads of the nails. Now straighten the nails to increase tension in the line and lower the line until it is about one-half inch above the board. Place the meter stick lengthwise between the nails. Stand a small piece of meter stick, or comparable width block, on edge under the string at the nine-inch mark. Place little folds of paper at 13½-, 18-, 22½-, 27-, 31½-inch marks. Pluck the short section of the string and note that the paper folds at 13½-, 22½-, and 31½ inches fall off, showing that the string is vibrating in four equal sections. Point out that different instruments tend to emphasize certain overtones and even leave some of them out. It is this difference in overtone series and the relative strength of them that gives each instrument its tone quality.

(d) Use eight thin glasses that produce a musical sound when struck. Line them up and fill each one with a different amount of water. By properly adjusting the water level in each, they can play a musical scale.

(e) Use four small soda bottles to play "Taps." Leave bottle one empty. Put about 2 inches of water in bottle two, 3 inches of water in bottle three, and fill the last bottle to the halfway mark. Blow across each one in order to see if you get the note of "Taps." If a note appears too high, decrease the level of water; if too low, add some water. See if you can play "Taps" with these. For example; the first part, play bottles 1-1-2, 1-2-3, 1-2-3, 1-2-3, 1-2-3 ...

## Additional Suggested Materials:

(1) Recording: "Music from Mathematics"
(33 1/3 rpm.) Bell Telephone Company

This recording best describes various ways in which a computer was programed to produce musical tape.

(2) Film: "Donald Duck in Mathmagicland"
Walt Disney Studio

This film explains the mathematics of music.

**Curriculum Area:** Science - Light (color)

**Cultural Item:** (Slides and booklet) "A Slide Lecture by National Gallery" 40 Slides and booklet

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**Preparation of the Class:**

This lecture and accompanying slides will illustrate: the five most often used techniques in painting, the pigments, and binders which hold the pigments to the base.

**Pupils Should Look For:**

- Earth colors
- Mineral pigments
- Animal and vegetable pigments
- Colors manufactured by chemical processes
- Various kinds of binders
- Egg tempera painting
- Fresco painting
- Gesso, oil, and glaze techniques

**Pupils Should Listen For:**

- Origin of pigments
- Varieties of techniques

**Presentation of Slides.**

**Follow-up Activities:**

Stimulate a class discussion through the use of the following questions.

(1) What are the advantages of each of the following as practiced by Monet, Cezanne, and other Impressionists.
  (a) oil and varnish binders
  (b) fresco
  (c) egg tempera
  (d) direct painting

(2) Describe "earth" palette and name some painters who used it.

(3) What aspect of science made the Impressionist palette possible?

(4) Ask the pupils to notice the National Gallery reproductions in the halls and see if they can recognize the type of pigments and techniques used.

**Curriculum Area:** Science - Sound Waves

**Cultural Item:** (Film) "Sound Waves and Their Sources"
11 min. (black and white).
Encyclopaedia Britannica Films

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### Preparation of the Class:

(1) Before meeting with the class, place the following terms on the chalkboard. During explanation and discussion of sound, reference should be made to these terms and the concept involved should be developed.

frequency
condensation
rarefaction
oscilloscope
partial
velocity
amplitude
pitch
vibration
compound tones

(2) The teacher may explain that sound is produced by vibrations which cannot be seen. However, when a tuning fork is struck and then placed in a dish of water immediately, the effect of these vibrations can be seen easily. When the prongs vibrate, they set up invisible waves in the surrounding air. These waves are transmitted by air molecules which are the result of alternate zones of condensation and rarefaction of the molecules. This film will show this process clearly.

### Pupils Should Look For:

- How sound waves are produced
- What determines frequency
- What determines loudness
  (The larger the displacement of particles (amplitude) the louder the sound)
- What determines velocity
- What determines pitch
  (The frequency of a vibrating string depends upon the string's length, thickness, and tightness.)
- How human speech is produced
  (Through vibrating column of air in mouth, head and trachea)

### Presentation of the Film.

### Follow-up Activities:

(1) Discuss with pupils the understandings pointed out in "Look For" and the definitions of new terms.

(2) Discuss how sound is produced in:

    (a) Stringed instruments
    (b) Drums
    (c) Brass instruments

(3) Have pupils construct a cardboard instrument of a box or boxes and rubber bands.

(4) By plucking, have pupils demonstrate:

    (a) Fundamental tone (longest wave length)
    (b) A second partial (half of fundamental tone)
    (c) A third partial (half of second partial)

(5) Fill test tubes in a rack with varying amounts of water. Have pupils blow to produce varying tones. Ask them to explain why tones vary.

(6) Some pupils may wish to carry this activity to the point of playing a tune, such as "Yankee Doodle."

(7) Some pupils may wish to construct varying musical instruments from boxes, plywood, tin cans, or other usable materials that lend themselves to this purpose.

(8) Ask the music teacher to follow up with a demonstration of how sound is produced on various musical instruments.

**Curriculum Area:** Science - Origin of the Earth

**Cultural Item:** (Film) "A World is Born"
20 min. (color). Walt Disney Films

**Preparation of the Class:**

(1) Scientists today have estimated the age of the earth at about 4½ billion years. However, there are many questions still unanswered as to how the earth was formed, and how life on the earth began, and what course living organisms have followed from the earliest living forms to present-day life.

(2) Outline on the board the following time scale for the pupils.

| Years Ago | Characteristics of the Time |
|---|---|
| 4½ billion | The earth emerged as a gaseous body. |
| 2 - 1 billion | The earth cooled down through the molten stage to a temperature that would support life. |
| 1 - ½ billion | The emergence of one-celled marine organisms. |
| 400 million | Fossil findings show that many forms of marine life were present. |
| 300 million | Dinosaurs were dominant. |
| 100 million | Mammalian groups emerged. |
| 1 million | Man-like beings emerged. |

(3) Indicate to the pupils that the film they are about to see is an animated picture of the earth as it has evolved through the ages. The fantasia produced, however, is based on scientific theories generally accepted today.

**Pupils Should Look For:**

- Condition of the earth in its initial stage
- Early living forms
- Stages through which animals are thought to have evolved
- The way in which the "Survival of the Fittest" theory is illustrated
- The beauty and wonder of creation

Pupils Should Listen For:

- The theory of how life began
- The stages of development in living forms
- The way in which the music supports the action in the life struggle scenes. This is Stravinsky's "The Rite of Spring."

Presentation of the Film.

Follow-up Activities:

(1) Develop a class discussion using the following questions as guides.

(a) How are scientists able to date the earth's beginning?
(b) What evidence leads scientists to believe that the earth was probably in the molten stage for such a long period of time?
(c) What does the film point out about the theory of the "Survival of the Fittest?"
(d) What theory about the emergence of life is presented by this film?
(e) Why do scientists believe that life began in a period preceding that from which we have fossil records? (Early animals were simple-structured; soft-shelled marine animals left no fossil records).

(2) Have some of the pupils who have ability and interest in art produce some art work depicting the earth at some of its various stages in development.

Additional Suggested Materials:

Film: "The Dinosaur Age"
13 min. (color). Film Associates of California

This film gives an excellent account of life on earth during the period when dinosaurs reached their peak.

## Project CUE Evaluation Sheet

(Science)

**Name of Cultural Item:** ______________________________

**Effectiveness:** (Check one)

___Excellent ___Good ___Fair ___Poor

**Suggestions:**

Tear here

## Project CUE Evaluation Sheet

(Science)

**Name of Cultural Item:** ______________________________

**Effectiveness:** (Check one)

___Excellent ___Good ___Fair ___Poor

**Suggestions:**

Tear here

## Project CUE Evaluation Sheet

(Science)

**Name of Cultural Item:** ______________________________

**Effectiveness:** (Check one)

___Excellent ___Good ___Fair ___Poor

**Suggestions:**

## Project CUE Evaluation Sheet

(Science)

**Name of Cultural Item:** ____________________

**Effectiveness:** (Check one)

___Excellent ___Good ___Fair ___Poor

**Suggestions:**

Tear here

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**Suggestions:**